POWER PLANT ENGINEERING

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From Feather Beds to Silver Spoons

FEATHER BEDS were common in western Nebraska at the time this picture was taken. Ticks were used both as mattresses and blankets on cold nights. Geese shot by the wagon load in the water valley (English equivalent for the Indian word Nebraska) were the unlucky victims that furnished those pioneers their feather beds. Pretty soft, now, wasn't it, when a one-armed soldier with a family of girls could select a quarter section of land and without money build a home all his own with complete water works like that shown above—and sleep in feather beds?

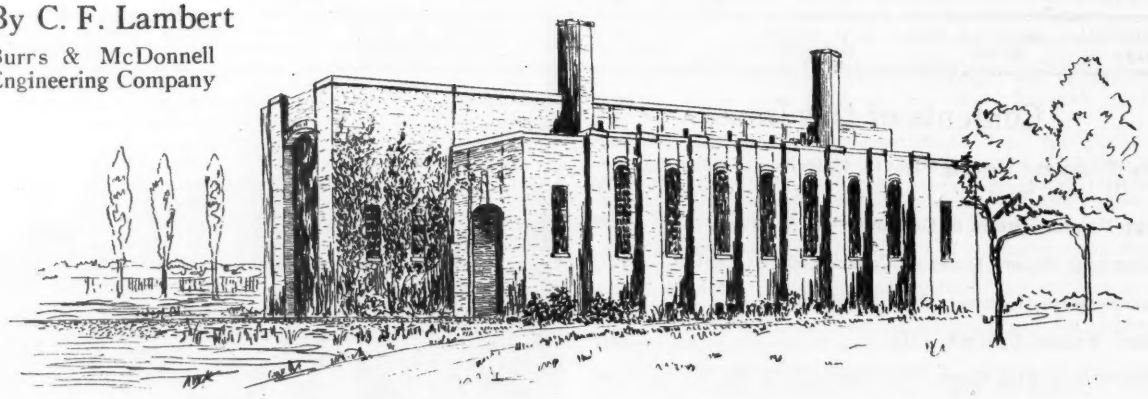
Perhaps he did not appreciate the liberties available to him. Of rain there was little, of wind there was much. Trees could not be seen for miles; sunflower weeds and dried buffalo chips cooked his meals and kept him warm. The gentle snows whipped into three-day blizzards, summer zephyrs into tornadoes, showers into hail storms. O yes, and the grasshoppers had to be fed, the coyotes made the night hideous in their raids upon domestic stock; snakes, both bull and rattle, migrated to the newly built sod house to welcome the newcomers.

Indians had their peculiar kind of fun with the homesteader with such stars as Sitting Bull and Spotted Horse playing leading roles, trying the wits of scouts like Buffalo Bill and Jim North. Then came Jesse James and his band of raiders and horse thieves to play their games (more civilized and quite modern) with the settlers and immigrants.

But the air was invigorating, the sunshine glorious, the water from the well cool, pure and refreshing, and the feather beds restful. It was under such circumstances that the seed for the University of Nebraska was sown and nourished through drouths, floods, pestilence, plagues, panics and business depressions until today, through the services of a new power plant, described on the following pages, every modern convenience known to educational institutions is supplied to its students.

New Power & Heating Plant *for* University of Nebraska

By C. F. Lambert
Burns & McDonnell
Engineering Company



DUE TO THE CONTINUED growth of the University of Nebraska, the officials had felt for several years that a larger and more modern heating and power plant was needed. The University is located at Lincoln, Nebraska, which is the Capital of the State. A new Capitol building has been under construction for some time. This building was heated temporarily from the heating plant of the old Capitol building, which, of course, was quite inadequate. The Capitol building is located about one mile from the University and it was felt that if a single plant could be built to serve both the University and the Capitol it would be economical and desirable for all concerned.

Early in 1928, the engineers prepared a preliminary estimate covering first a plant for the University only and second a plant and heating main to serve both the University and the Capitol. The estimate for the first plant was $421,000 and for the combined plant was $598,000.

At the session of the legislature in the spring of 1929, funds were appropriated for the combined plant, with an arrangement by which the University was to pay 60 per cent and the State 40 per cent. The law arranging for the funds provided for a commission which was a Joint Commission of the Capitol Commission and the Board of Regents of the University. The old heating plant of the Capitol was on its last legs and it was necessary that heat be furnished for the winter season of 1929-30, for the Capitol building. As it was in May, 1929, before funds were ready, it was deemed improbable that the new heating plant could be in readiness; however, it was found that if the heating main could be installed, a connection could be made to the existing University Plant and the Capitol could be taken care of. It was therefore imperative that the heating main contracts be awarded without delay.

C. F. LAMBERT
Burns & McDonnel Eng. Co.
Kansas City, Mo.

The following requirements were found to exist and the design of the plant and system based thereon:

Present maximum demand for steam for one hour for university	78,000 lb.
For 50 per cent expansion	39,000 lb.
Maximum demand for capitol	36,000 lb.
Total maximum per hour	153,000 lb.
Normal boiler hp. rating for maximum hour	5100 b.hp.
Average boiler hp	1300 b.hp.
Minimum boiler hp	700 b.hp.
Maximum demand for electric power	2000 kw.

Allowing for 250 per cent rating on the boiler, it would require about 2270 boiler hp. to carry the peak load. Three 800-hp. boilers would carry this load. Adding one 800-hp. for reserve, an installation of four 800-hp. boilers was suggested. For the electric demands, two 1500-kw. turbines were suggested.

On July 3, 1929, contracts were awarded for the heating main, boilers, stokers, switchboard, turbines, condensers, cooling tower and coal and ash handling equipment. These contracts were awarded first so that work could be started immediately on the heating main, and so that plans for the foundations, building, piping, etc., could be in progress during the construction of the larger items of equipment and thus the whole program be expedited as much as possible. Other contracts followed as rapidly as plans could be prepared and bids received, and all contracts had been awarded late in 1929.

Heating Main

The existing heating mains on the University grounds were all carried in tunnels. Part of this system could be used and additional tunnels were constructed to connect these with the new plant and to the edge of the University grounds at 14th and R Streets. This was a

total of about 1050 ft. of tunnel, 8 ft. wide by 7 ft. 4 in. high. The balance of the main was carried in conduit thence to the Capitol building, a distance of approximately 3665 ft. A small conduit also ran from there to the Governor's Mansion across the street. The tunnels were constructed of reënforced concrete. The conduit consisted of a concrete encasement which enclosed the insulated heating main and return and an electric cable for power. The mains consisted of 1260 ft. of 10-in. main and a 4-in. return from the heating plant to a point where a branch high-pressure line extends to the mechanical building. From here to the Capitol the line consists of 4690 ft. of 8-in. main and 3-in. return. The specifications called for the mains to be extra heavy pipe with expansion joints and fittings of extra heavy cast steel for use with 250 lb. pressure and 150 deg. superheat. The returns are all of genuine wrought iron. For the present, a reducing valve at the end of the 10-in. line reduces the pressure to 125 lb. as the size of the lines was figured to carry the amount of steam required for the present at this pressure. The line was designed for the higher pressure so that the capacity could be greatly increased in the future if necessary by simply increasing the pressure. The cable consists of a three conductor No. 00 cambric insulated and lead covered for 2300 v. service. This cable is carried in fibre conduit in the concrete encasement. The heating main was completed in time for the heating season of 1929-30. Tests made for temperature showed no undue heating effect on the cable.

Building

The building consists of a boiler room 188 ft. 10 in. by 48 ft. 4 in. and 59 ft. high from basement floor to roof, and an engine room 156 ft. 3 in. by 29 ft. 10 in. and 46 ft. 6 in. high from basement floor to roof.

There is an office and wash room in one end of the engine room and a pump room and meter testing room in the center of the boiler room. Space is left for an additional boiler and an additional turbine. The building is a handsome brick structure which enhances rather than detracts from the beauty of the campus. The two stacks of the same brick as the building and of a special artistic design add to the pleasing appearance. The stacks are 7 ft. 0 in. diameter by 33 ft. 0 in. high above the boilers.

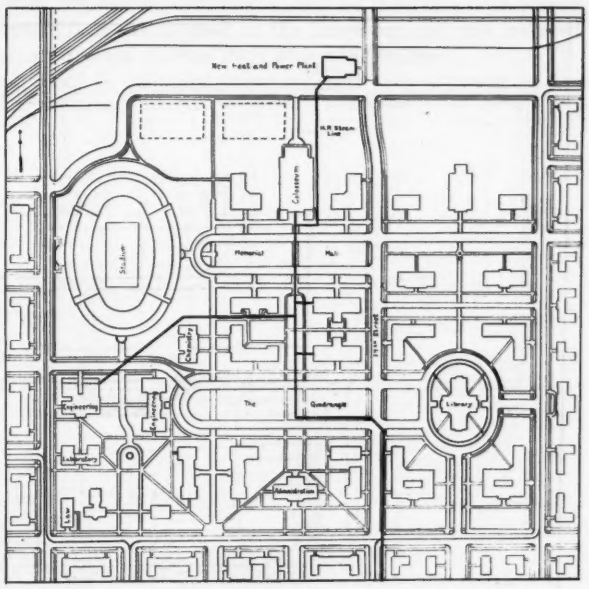


FIG. 1. PLAN OF CAMPUS SHOWING LOCATION OF HIGH PRESSURE STEAM LINES AND POWER PLANT

Boiler Plant

The boiler plant consists of four 800-hp. boilers, three of which are new and one about two yr. old, which together with its stoker was moved from the old plant. The boilers are of the longitudinal drum type designed for operation at a pressure of 250 lb. They are equipped

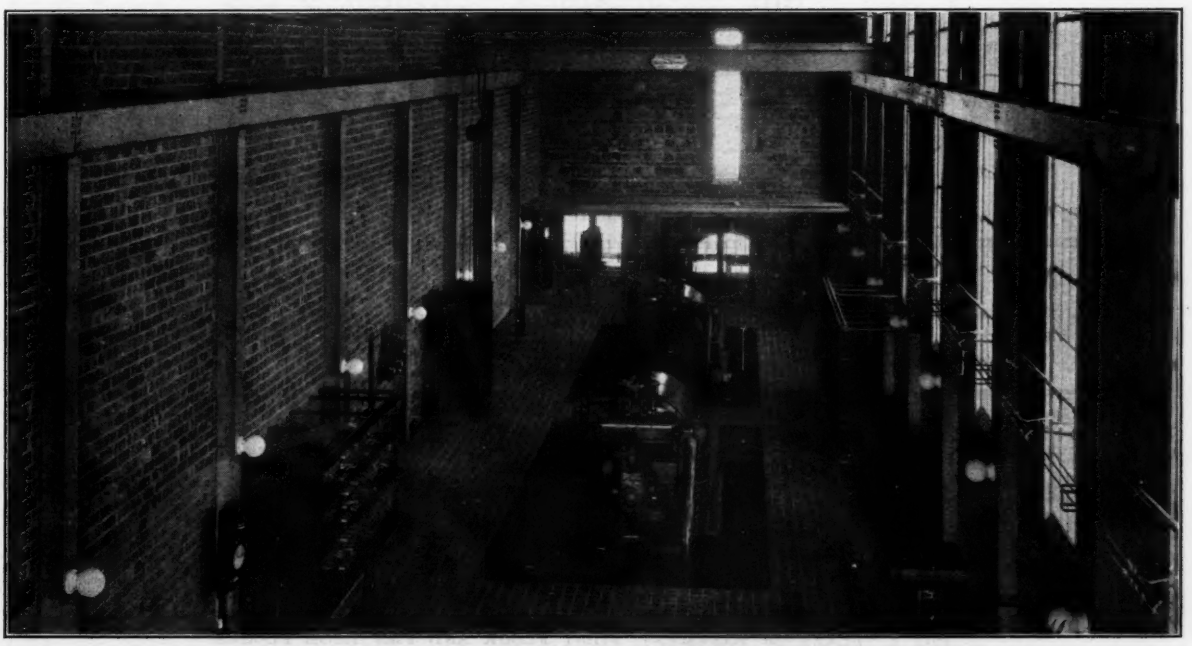


FIG. 2 AN INTERIOR VIEW OF THE TURBINE ROOM

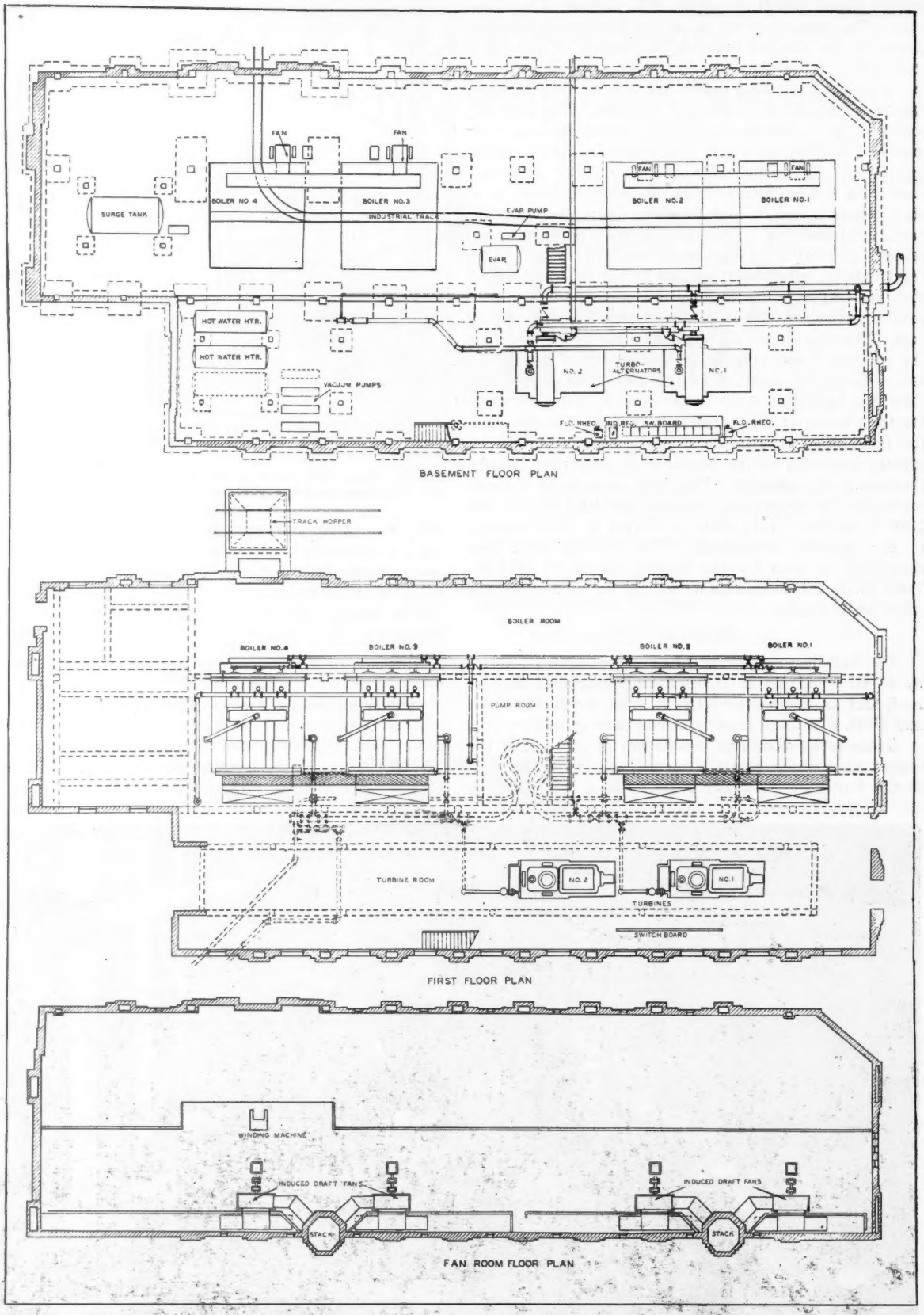


FIG. 3. PLANS OF BASEMENT, FIRST FLOOR AND FAN ROOM FLOORS

with superheaters to give a superheat of 150 deg. at full load. The stokers are of the underfeed type and have 25 tuyeres and eight retorts each. Boilers are also equipped with soot blowers and feedwater regulators. with an economizer should such be desired. The forced draft fans are located in the basement and the induced draft fan on the fan floor above the boilers.

Coal is unloaded from railroad cars adjacent to the

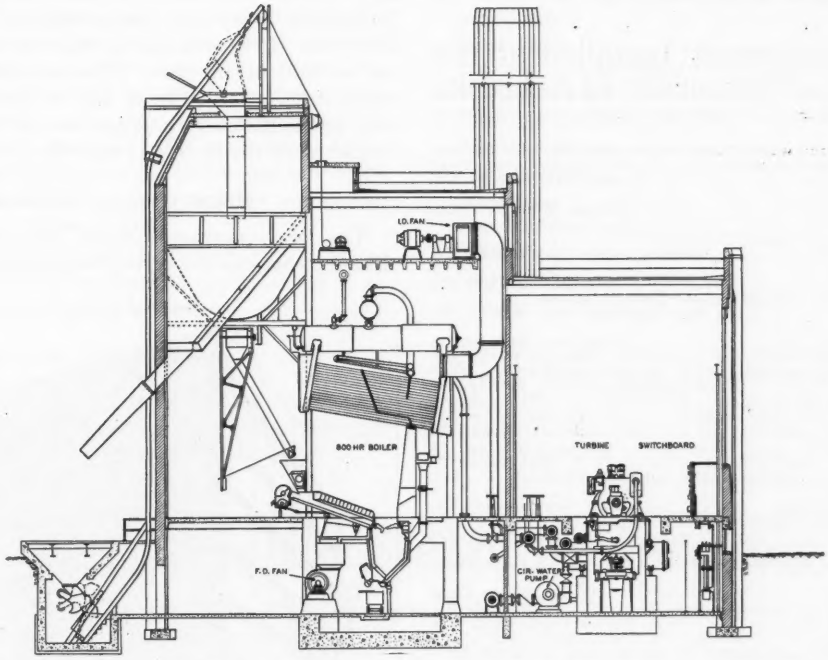


FIG. 4. SECTION THROUGH POWER PLANT

As shown in the cross section, Fig. 4, there is a forced draft fan and induced draft fan for each boiler. The induced draft fan is of sufficient size to be used later boiler room. A railroad crane can take the coal and distribute it to an outdoor storage with a capacity of about 5000 tons. From the cars the coal can be dumped

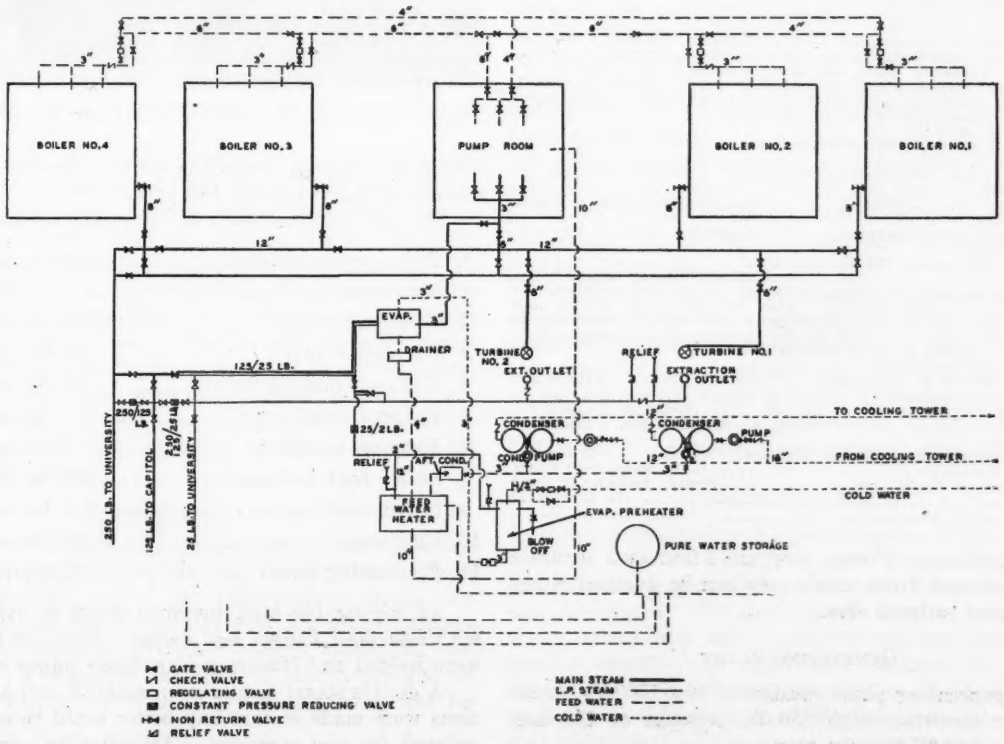


FIG. 5. FLOW DIAGRAM OF THE UNIVERSITY OF NEBRASKA POWER AND HEATING PLANT

into a hopper from which a skip hoist lifts it to a 150-ton horizontal elevated storage. Thence it is carried by means of a one-ton weigh larry to the various boilers. Ash is dumped from the bottom through Beaumont counterweighted gates to push carts, and carried to the same skip hoist. Thence they are lifted to a separate 25-ton ash tank from which they can be dumped either to trucks or railroad cars.

Principal Equipment Installed at the Power Plant of University of Nebraska

Boilers:
4 800-hp. long drum water-tube boilers, designed to operate at 250 lb. gage with superheaters to give 150 deg. superheat at full load.....Murray Iron Works Co.
Superheaters:
Convection type .....Foster Wheeler Corp.
Stokers:
8 Retort—25 Tuyere underfeed type.....
.....Westinghouse Elec. & Mfg. Co.
Induced draft fans:
4 single inlet type.....American Blower Co.
Driven by 60-hp. variable speed electric motor.....
.....Westinghouse Elec. & Mfg. Co.
Forced draft fans:
2 single inlet type.....American Blower Co.
2 single inlet type.....Buffalo Forge Co.
Driven by 40-hp. variable speed electric motors.....
.....Westinghouse Elec. & Mfg. Co.
Feedwater regulators:
1 Copes regulator on each boiler.....Northern Equipment Co.
Soot Blowers .....Vulcan Soot Cleaner Co.
Blowoff Valves.....Yarnall-Waring Co.
Ash Hoppers.....R. H. Beaumont Co.
Safety Valves.....Consolidated Ashcroft Hancock Co., Inc.
Boiler Brick Work:
Standard brick setting.....Rau Construction Co.
Coal & Ash Handling Equipment:
Overhead bunkers and skip hoists.....R. H. Beaumont Co.
Draft Gages:
1-4-point gage on each boiler.....Hays Corp.
CO_2 Recorder:
1 on each boiler.....Hays Corp.
Flue Gas and Furnace Thermometer:
1 on each boiler.....Taylor Instrument Cos.
Steam Flow Meters:
1 on each boiler; indicating, recording and integrating type.....Cochrane Corp.
Boiler Feed Pumps:
2 turbine driven, centrifugal type TS, 153,000 lb. per hr.
.....Worthington Pump & Machinery Corp.
Driven by 100-hp. electric motor.....
.....Westinghouse Elec. & Mfg. Co.
1 3-stage centrifugal, 65,000 lb. per hr.....
.....Worthington Pump & Machinery Corp.
Driven by a 45-hp. steam turbine.....
.....Westinghouse Elec. & Mfg. Co.
Excess Pressure Governors:
Copes.....Northern Equipment Co.
Instruments:
Every turbine is equipped with a Cochrane indicator, recording and integrating steam flow meter, a Brown recording steam pressure gage and thermometer and a Brown recording thermometer for exhaust and condensate, also a Brown recording thermometer for condenser, circulating water, inlet and outlet temperatures.
Steam Flow Meters:
For State Capitol high-pressure line.....Bailey Meter Co.
Turbines:
Four 1500 kw. Horizontal Condensing....General Electric Co.
Condensers:
Four 2500 sq. ft. Surface.....Worthington Pump & Mach.
Switchboard:
Nine panel hand-operated.....Westinghouse Elec. & Mfg. Co.
Cooling Tower:
Double 3200 g.p.m. Mechanical Draft.....
.....Standard Power Equip. Corp.
Two Marsh and one Deane vacuum pumps are used on the Campus heating system. Also two National Brake and Electric Company air compressors are used for maintaining a constant air pressure on the thermostatic control valves in the campus heating system.
Boiler Feedwater Heater:
153,000 lb. per hr. capacity.....Elliott Co.
Evaporating Equipment:
Capacity—12,500 lb. vapor per hr.....Griscom-Russell Co.
Valves.....Chaplin Fulton Co.
Pipe Bends:
Van Stone Flange and pipe fittings.....Crane Co.
Erecting Turbines.....R. E. Townsend Corp.
Foundations & Buildings.....Ernest Rokahr & Sons
Piping.....B. Grunweld

Generating Plant

The generating plant consists of two 1500-kw. turbo units for operation with 250 lb. pressure at 150 deg. superheat and 27.5 in. vacuum.

Turbines are arranged for bleeding maximum extraction of the steam at 25 lb. for heating. During the winter, additional live steam is, of course, required. During the summer the turbines are operated condensing. Surface condensers are used, with a cooling tower. The cooling tower is of the mechanical draft type with four fans. It is arranged so that one-half of the tower can be used at one time. The switchboard consists of nine panels. The switches are all located in the basement under the board and operated by bell cranks. The frequency of the system is controlled by a master clock.

Miscellaneous Equipment

The final contract included the furnishing of all piping, steam and water, induced draft fans, evaporator, heater, feed pumps, breeching connections, etc., also the moving of the old boiler and stoker.

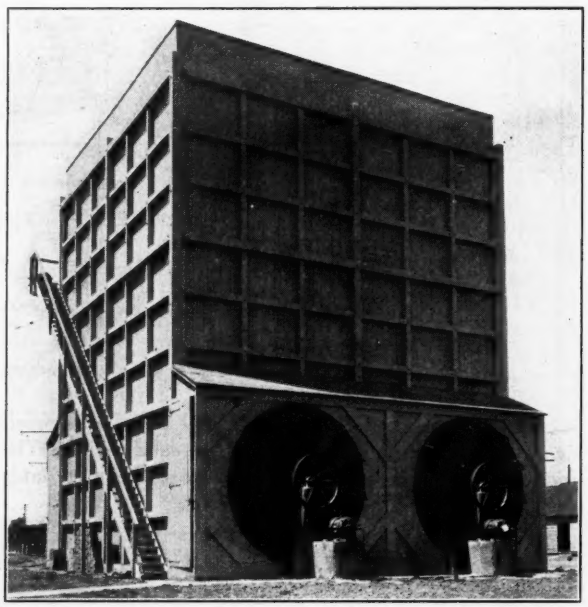


FIG. 6. THE COOLING TOWER ADJACENT TO THE PLANT

The general conditions of operation are as follows:

1. High pressure steam.....250 lb. per sq. in.
2. Superheat .....150 deg. F.
3. Evaporator vapor .....125-25 lb. per sq. in.
4. Extraction vapor ..... 25 lb. per sq. in.
5. Exhaust, heating return..... 40 lb. per sq. in.
6. Exhaust, condenser .....28 in. vacuum
7. Exhaust, auxiliary ..... 2 lb. per sq. in.
8. Boiler feed discharge.....300 lb. per sq. in.
9. Compressed air .....125 lb. per sq. in.
10. City water ..... 60 lb. per sq. in.
11. Circulating water ..... 12 lb. per sq. in

All piping for high pressure steam is extra heavy with cast steel flanges and valves. Many of the joints were welded and otherwise Van Stone joints were used.

A double steam header was installed and all connections were made so that any boiler could be completely isolated for test purposes. All necessary instruments

for measuring and regulating water, steam and pressure were provided, with many special ones, having in mind the fact that the plant would be a laboratory as well as a power plant. The instruments include indicating, integrating and recording steam flow meters for each boiler and for each turbine, draft gages, boiler feedwater meter, temperature recorders, etc. The evaporator is of the submerged type, single effect, and is used for supplying distilled make-up water to the feedwater system. It is equipped with an open type feedwater heater for preheating the raw water to the evaporator, motor driven centrifugal type pump for delivering raw water to the evaporator and trap for returning condensate from evaporator to station heater.

The evaporator is designed to furnish 12,500 lb. per hr. of make-up water in the form of dry steam at 25 lb. pressure to be used in heating system.

Cost of Construction

The final cost of construction was as follows, the low cost of many of the items being due to the educational discounts to which the University was entitled:

Steam main	$101,661
Locomotive crane	3000
Boilers	62,381
Stokers	24,258
Turbines	54,412
Switchboard	5127
Condensers	17,226
Coal and ash handling	23,700
Cooling tower	10,600
Erecting turbines, etc	8300
Bricking boilers	16,035
Foundations	17,577
Piping	88,700
Miscellaneous equipment	5327
Building	129,566
Engineering	25,000
Total	$592,870

The plant was designed and supervised by Burns & McDonnell Engineering Co. of Kansas City and Los Angeles. The building was designed by Davis & Wilson, architects of Lincoln, and the heating main was supervised by Grant & Fulton, Engineers of Lincoln.

High-Pressure Steam in Germany

Conclusions Reached by Engineers Regarding Costs, Materials and Designs

APPLICATION of the laws of thermodynamics has resulted in increase during the last few years from former steam pressures of 200 to 290 lb. to modern pressures of 420 to 575 lb. and experience with the latter has been satisfactory.

With higher pressures, German power plant engineers have been cautious, which is understandable since safety and reliability of stations are considered more important than economy. Some pioneers have, however, gone ahead and it is interesting to know something of their experiences.

In general, the opinion seems to be that very high pressures are economical only with back pressure engines. In his paper, No. 167, before the Second World Power Conference, Ing. A. Demmer shows that each kilowatt-hour generated with high steam pressure requires 4166.7 B.t.u. in condensing prime movers but requires 5358.2 B.t.u. with back pressure and exhaust steam used for heating. This is because with higher pressure, higher feedwater preheating by steam lowers condenser loss, while, with back-pressure plants no corresponding gain is possible. This seems to oppose the general opinion as to economy of high pressures for condensing plants.

Construction Costs

In all cases, higher steam pressure means somewhat more expensive construction, but Dr. F. Marguerre, a leading German expert on high-pressure steam, has shown that besides the greater cost for boilers, valves, pumps and the like, offsetting savings should be considered.** Comparing the costs of plants for 425 lb. and for 1400 lb., he finds 14 per cent greater cost for the latter for plants of the same output but only 1 per cent greater for those of the same coal consumption.

Dr. Muenzinger, another German expert, assumes that the rise in cost for a 1420-lb. plant over that for a 425-lb. plant of like capacity will be about 7 per cent. This difference will probably become less as more high-pressure plants are built.

In the superpower Mannheim station on the Rhine, steam at 1420 lb. is generated in vertical water-tube boilers with two drums, fired with powdered fuel. Each boiler has an output of 139,000 lb. of steam an hour. In one of the first boilers installed, tubes in the combustion chamber, in the front wall and the furnace roof were separated, giving several systems of water circulation in the boiler. Experience was such that this combination will not be repeated.

Water circulation is of great importance since the difference of specific weights of water in upflow and downflow tubes is less at 1420 lb. than at lower pressures, also a smaller amount of heat vaporizes a larger amount of water after the water is heated to boiler temperature. Possibility that these characteristics might cause difficulties has led to special construction as described below.

Boiler Materials

Since high-pressure boiler drums are heavy and expensive, designers generally seek to make them small and to utilize capacity fully by good circulation of steam and feedwater. We understand that in the United States open-hearth steel is largely used but German engineers mostly use nickel-steel because its greater strength at high temperatures permits of using thinner walls, hence lighter drums. Furthermore, they assume that nickel-steel will be less affected by ageing.

*Dipl. Ing. Berlin, Germany.
**Zeit. Ver. Deutsch Ing. Vol. 74, p. 789.

Recently molybdenum steel has been tried for tubes. This saves some 30 per cent of wall thickness as compared to open-hearth steel so the higher price of molybdenum steel is offset by the less weight needed. Also the thinner walls are less subject to unequal expansion stress caused by great temperature changes, hence are safer.

One fundamental necessity for high-pressure boilers is a good method of feedwater treatment because of rapid chemical reactions at high temperatures and high rates of heat transmission through the heating surfaces. German experience shows that oxygen content should be less than 0.035 cc. per litre. With good condensers, it is possible to keep even below this limit without difficulty. As to the best chemical treatment for feedwater, experts fail to agree except on the point that the feedwater should have slight alkalinity.

Special Designs

Feedwater and circulation requirements, already mentioned, have led to some special designs and methods. The Schmidt superheated steam equipment of Rassel uses tubes in coils or other bent forms as heating surface, through which the same water circulates continuously, free of scale and oxygen. It is vaporized and the steam so formed transfers its heat to the working boiler feedwater through other heating surfaces.

One of the most interesting of the Schmidt high-pressure boilers is on a locomotive for express service on the German State Railways, the first high-pressure locomotive in the world. It has a high-pressure cylinder 11.42 in. diam., two low-pressures 19.69 in. diam. and 24.8 in. stroke. Total weight is 102 t. and highest speed 68.5 mi. per hr. Steam is made at 852 lb. and expanded in the high-pressure cylinder to 199 lb. It is then nearly saturated and is mixed with highly superheated steam from a low-pressure boiler, that boiler being fired by exhaust gases from the high-pressure boiler.***

First trials showed some unsymmetrical distribution of pressure in the heating elements and the boiler was partly rebuilt. Later trials showed fuel savings of 25 and 30 per cent over locomotives of usual design.

In the Loeffler method, steam is circulated by a pump, superheated steam entering the water of a vaporizer, whose steam is pumped into a superheater. Part of the superheated steam enters the prime mover, the rest returns into the water of the vaporizer to generate fresh steam. Loeffler utilizes the fact that high-pressure steam, even at low velocities, has as high a rate of transfer from tubes as does water. Plants on the Loeffler system are installed in Florisdorf near Vienna and at Witkowitz. They have passed the trial stage and are now in regular service, so that operating results should be available soon.

Another locomotive of the German State Railways has a Loeffler boiler, of a special design to meet locomotive conditions. One of its advantages is positively controlled water circulation, which prevents local excessive heating and permits coördination of fuel feed with steam generation. This locomotive has an output of 2600 hp. and maximum speed of 74.5 miles per hour. The high-pressure cylinders are 8.66 in. diam., low-pressure 23.62 in. diam. and stroke 25.98 in. Total weight is 1260 t. Steam is supplied to the high-pressure cylinders at 1565 lb. and 860 deg. F. and expanded in them to 242 lb. and 482 deg. F. The output of these cylinders is ⅔ the total of the locomotive. Their exhaust steam passes to the low-pressure vaporizer which it leaves at 242 lb. and 398 deg. F. Water enters this low-pressure boiler at 64 lb. and 59 deg. F. and steam leaves it at 383 deg. F. This locomotive is guaranteed to save 42 per cent of the coal so that grate area can be much smaller than for usual designs.****

In the Benson boiler, water is vaporized at its critical temperature, 705.2 deg. F., and at 3188.85 lb. pressure.

Evaporation consists merely of heating the water to that temperature, circulation being by pumps through the tubes, and no heat being needed for vaporization, since water and steam have the same volume at critical temperature.

Siemens Works have two experimental boilers at their Berlin plant, one with output of 22,000 lb. of steam an hour, the other for 78,000 lb. an hour. Steam is throttled from 3189 lb. to 1422 lb. for use in the turbines at 752 deg. F. The second boiler can deliver a maximum of 100,000 lb. of steam an hour.

It is stated that another boiler is under construction for a power plant in Belgium to deliver 220,000 lb. steam rated, 300,000 lb. maximum an hour.

For test work, the Technical University at Berlin has a small Benson boiler, output 6600 lb. of steam an hour at 3271 lb. and 842 deg. F. on which Dr. E. Josse has made a number of fundamental tests.*****

As in other countries, German practice is working toward higher pressures. Some plants are pioneering but economic considerations prevent following as fast as technical progress might permit.

***Ver. Deutsch Ing., High-Pressure Steam II.

****Z. V. D. I. Vol. 74, p. 1073.

*****Z. V. D. I. Vol. 51, p. 1815.

American Standards Association has recently approved the revision of a group of nine national standard methods of test for petroleum products and lubricants. These methods of test, originally prepared and now revised under the sponsorship of the American Society for Testing Materials, are as follows: Viscosity of petroleum products and lubricants; water and sediment in petroleum products by means of centrifuge; water in petroleum products and other bituminous materials; distillation of gasoline, naphtha, kerosene, and similar petroleum products; distillation of natural gas gasoline; burning quality of kerosene oils; burning quality of mineral seal oils; burning quality of long-time burning oil for railway use; detection of free sulphur and corrosive sulphur compounds in gasoline; cloud and pour points of petroleum products, (American Tentative Standard); melting point of petrolatum, (American Tentative Standard); the determination of autogenous ignition temperatures, (American Tentative Standard).

Copies of the revised standards may be obtained from the office of the American Standards Association, 29 West 39th St., New York City, or from the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., for 25 cents each.

Direct current must be used to charge storage batteries. If alternating current only is available, it must be converted into direct current by a motor generator set, mercury arc or some other form of current rectifier.

Revamping Boilers

Increases Capacity 60 Per Cent

THE AMERICAN ROLLING MILL COMPANY ADDS WATER WALLS AND NEW STOKERS TO THREE 312-HP. BOILERS AND INCREASES CAPACITY FROM 265 TO 425 PER CENT RATING

POSSIBILITIES of revamping existing plants to take advantage of modern high capacity, high efficiency equipment are not always fully appreciated when additional capacity is required. Only too often a new plant is decided upon without giving proper consideration to remodeling with its attendant advantages. Fixed charges on the investment play an important part in steam or power costs and when we consider that the boiler and building costs form a large part of the total investment, the advantages of utilizing existing equipment when possible is apparent.

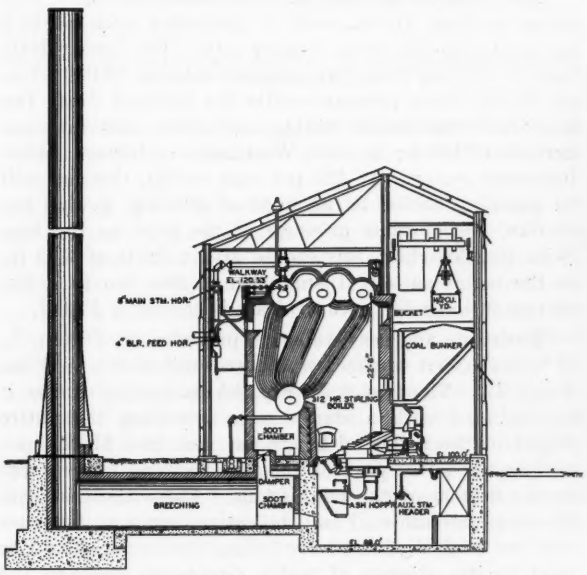


FIG. 1. CROSS SECTION OF THE THREE BOILERS AS ORIGINALLY INSTALLED

Such a course was adopted by the Ashland Division of The American Rolling Mill Co. at Ashland, Ky., where three 312-hp. Stirling boilers were revamped and the capacity increased approximately 60 per cent at a total cost of $73,166.14. Normal boiler capacity was increased from 200 to 325 and peak capacity from 265 to 425 per cent rating at a cost approximating $50 per b.hp. of peak capacity. The important point, however, is that the efficiency at normal rating was increased to 75 per cent, resulting in an annual coal saving of 14,000 t. based, of course, on the same steam load. As a matter of fact, the steam load has increased materially so that the actual saving in tons has been more than this.

This change was made by adding 280 sq. ft. of water walls and installing a new stoker with a grate area of 97.6 instead of 66.5 sq. ft. In order fully to appreciate the changes which have taken place and the equipment as installed, a brief review of the mill and boiler plant may be of advantage.

As originally installed in 1923, the Ashland Armco boiler plant consisted of three 312-hp. Stirling boilers set with the mud drums 8 ft. above the floor elevation and fired by Taylor AA6, four-retort, 17-tuyere underfeed stokers as shown in Fig. 1. With natural draft, the maximum capacity was 165 per cent rating (17,000 lb. per hr.).

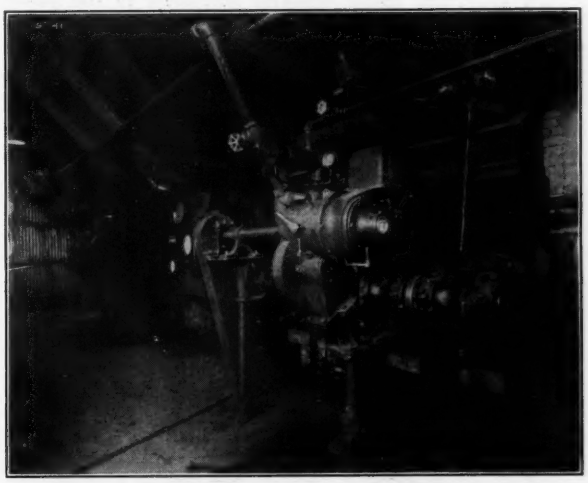


FIG. 1-A. FRONT VIEW OF TWO OF THE REBUILT UNITS

UNIT HEATER LOAD IN ONE PICKLING ROOM RUNS 10,000 LB. PER HR.

This plant served the first continuous sheet mill built and the process involves a mile and a half of continuous operation beginning with the blast furnace and ending in the finishing rooms and warehouses. Large quantities of steam and electrical power are used, the steam load now running around 110,000 lb. per hr. and the electrical demand about 17,000 kw. In one pickling room alone, the winter load for unit heaters, to prevent fog, is around 300 b.hp. or approximately 10,000 lb. of steam per hour. Steam is distributed at full boiler pressure of 175 lb. All power is purchased at 33,000 kv-a., 3-phase, 60-cycle. A portion of it is stepped down to 6600, 2300 and 440 v. and a portion converted to 250 v.d.c. The total installed capacity is about 50,000 kw. in motors ranging from ¼ to 3250 hp. rating. In November, 1924, the total production was about 12,000 t. of sheet per month; it is now 37,000 t., which gives an

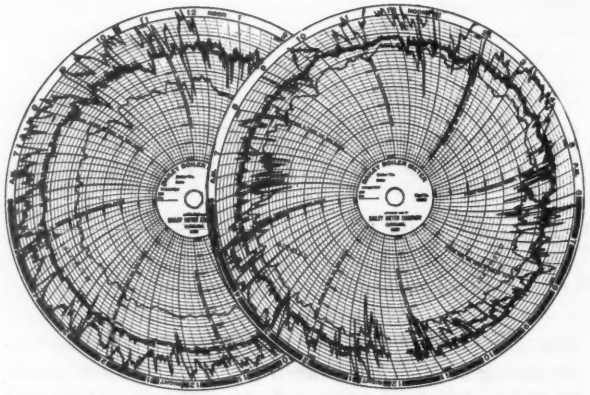


FIG. 2. TYPICAL CHARTS FROM THE NEW 312-B.HP. UNIT FIRED BY A SINGLE RETORT STOKER

indication of the change in demands placed upon the boiler plant. On the basis of a 20,000 t. per mo. output in 1926, the mill used 4,500,000 kw-hr. or about 225 kw-hr. per ton of sheet.

In 1927, the steam demand increased to the point where additional boiler capacity was needed and the addition of induced draft fans increased the maximum boiler rating to 250 per cent (25,000 lb. per hr.). Fans were installed as in Fig. 4, but were belt driven instead of direct connected as shown. In 1928, increased steam demand made further additions necessary and a fourth boiler, similar to the first three, that is a 312-b.hp. Stirling with a mud drum set 8 ft. above the floor, was installed at a total cost of about $62,000. This was fired by a Westinghouse single retort underfeed stoker 9 ft. long and 8 ft. wide with an area of 72 sq. ft.

This unit is also equipped with forced and induced draft fans and Thermix stack and has been operated continuously at a constant rating of 400 per cent. The stoker has burned as much as 63 lb. of coal per sq. ft.

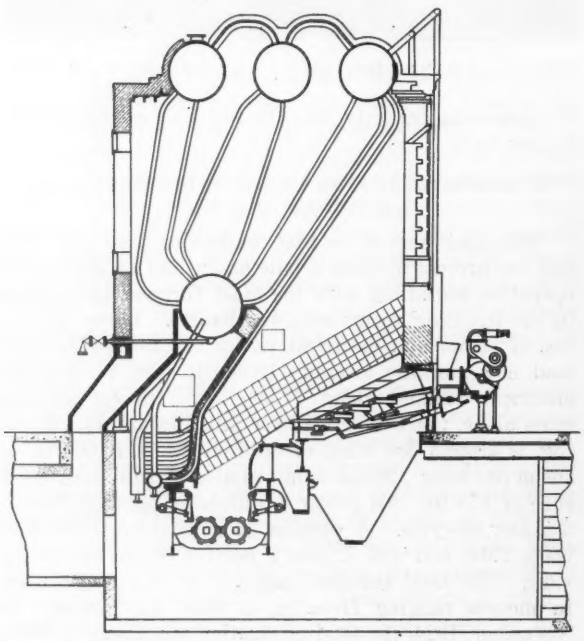


FIG. 3. THE SAME BOILERS AS IN FIG. 1 IN A NEW SETTING DEVELOP 60 PER CENT MORE STEAM

The combustion chamber has a volume of approximately 955 cu. ft. and 63 lb. of coal per sq. ft. of stoker area is equivalent to a heat release of about 58,000 B.t.u. per cu. ft. One of the typical steam flow air flow meter charts from this boiler is shown in Fig. 2.

As originally installed, the furnace was equipped with Bernitz air-cooled walls for 24 in. above the grates and No. 1 fire brick above this. At the high ratings maintained, the fire brick lasted only about three months. When the furnace was rebuilt, 12 in. of Carborundum brick was added above the Bernitz blocks and Oxpliable plastic fire brick installed above this. The maintenance on this new combination has been practically nil for the year that it has been installed in spite of the continued high ratings.

Again, in 1929, additional steam generating capacity was needed and this demand was met by revamping the three original 312-b.hp. boilers, as mentioned earlier in the article, by adding American Engineering Co. water-cooled walls, larger stokers and fans.

New stokers are Taylor four-retort, 25 GC7 unit steam turbine driven, with a projected area of 97.6 sq. ft. and double 18-in. crusher rolls. The forced draft fan is a Carling 28-in. turbo-blower rated at 18,000 c.f.m. at 5½-in. static pressure while the induced draft fan is a Sturtevant double width, single inlet multivane fan driven at 1160 r.p.m. by a Westinghouse 100-hp., 440-v. induction motor. At 425 per cent rating, this fan will be handling 78,000 lb. an hour of 800-deg. F. flue gas at 6-in. static water pressure at the inlet to the flue. With the flue clear, this should give a draft of 3.75 in. at the boiler outlet. Installation of this fan in a flue and stack built for natural draft is shown in Fig. 4.

Both side and rear walls are protected by 280 sq. ft. of water-cooled surfaces which are well shown in Figs. 3 and 3A. The rear wall, Fig. 4A, is unique in that it is combined with a slag screen extending the entire height of the boiler, although the cast iron blocks protecting the lower part of the tubes extend only as far as the bottom of the mud drum. Above the cast iron blocks of the side wall and the entire height of the front wall are B. & W. No. 80 fire brick. Attention should be paid to the absence of water circulators between the

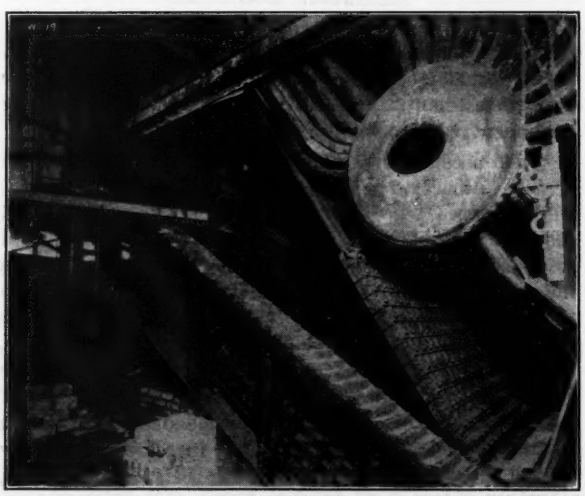


FIG. 3-A. AN UNUSUAL VIEW SHOWING THE WATER WALL AND SLAG SCREEN CONSTRUCTION

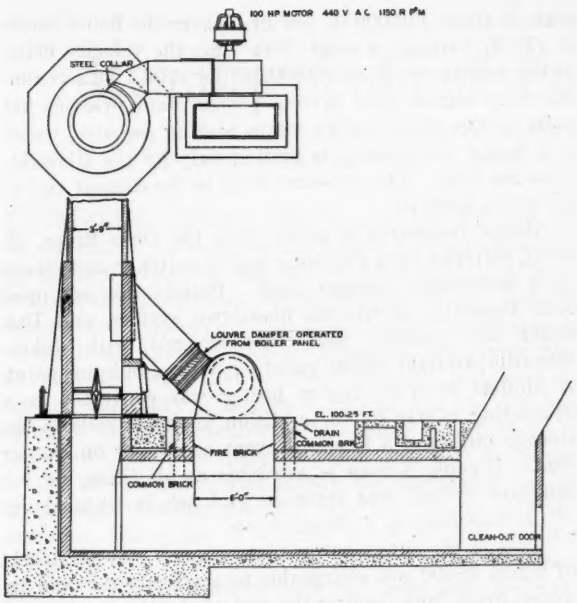


FIG. 4. ARRANGEMENT OF THE INDUCED DRAFT FAN AT THE STACK

steam drums in Fig. 3. At the recommendation of the boiler company, these were removed when the furnace was rebuilt.

In Fig. 5 are shown typical boiler meter charts for the old and the new setting. Charts have been reduced so that they are to the same scale; the actual chart in each case was the usual 12-in. chart but the old one covered a range of 0—300 per cent rating, whereas the new one ranges from 0 up to 500 per cent. The original units had a normal rating of 200 per cent (20,500 lb. per hr.) and a peak capacity of 265 per cent (27,700 lb. per hr.). As rebuilt, the normal capacity is 325 per cent (33,300 lb.) and a peak of 425 per cent (43,500 lb. per hr.); that is, the capacity has been increased from 825 to about 1400 b.hp., all these ratings being based on the boiler surface of 3120 sq. ft. without considering the water wall surface.

Overfire Air Used at High Ratings

Results of tests made on one of the new units, considering the entire heating surface, are shown graphically in Fig. 6. As the furnace volume is 840 cu. ft., it is seen that the heat liberation reached a maximum of 76,000 B.t.u. per cu. ft. Low efficiency at this point was due largely to the coal particles carried out to the flue because of the high velocity. The fuel bed was not in condition to carry the rating attempted at that time.

One of the most interesting features is the small amount of excess air carried on the last three points of the test. This was accomplished by the installation of some secondary air through the front wall immediately over the stoker retorts. A 2-in. line, visible at the extreme right-hand side of Fig. 1A, was run above each retort direct to the windbox and during the last two tests these air lines were run wide open. There was a fraction of a per cent of CO as indicated by notes on the CO_2 curve.

Feedwater regulators are not used on the boilers although the feedwater pressure is controlled by Copes

FIG. 4-A. THE SLAG SCREEN WITH THE LOWER PART PROTECTED BY CAST IRON BLOCKS

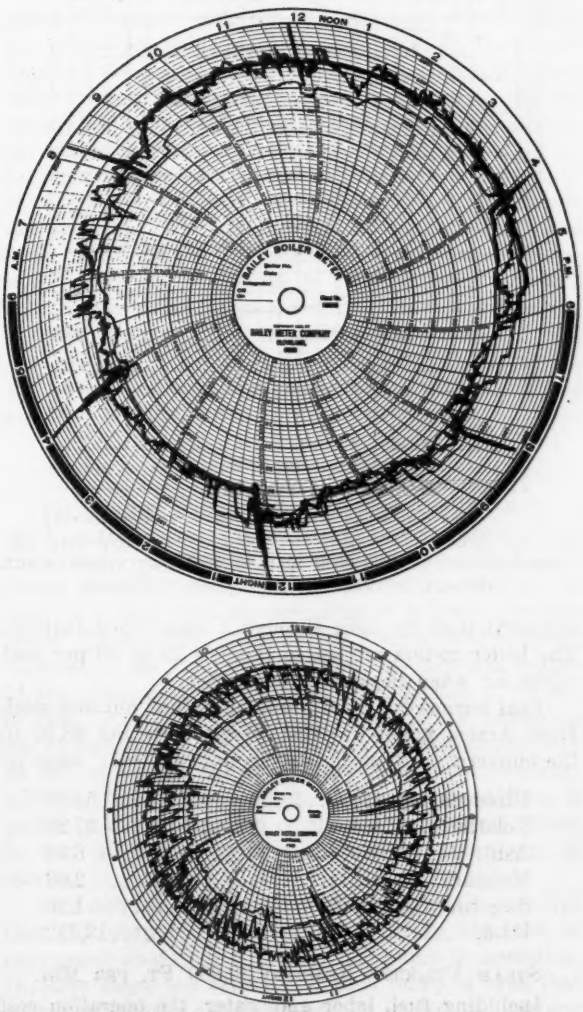


FIG. 5. METER CHARTS BEFORE (ABOVE) AND AFTER (BELOW) DRAWN TO THE SAME SCALE. NOTE THAT THE OLD CHART IS 0-300 PER CENT, THE NEW CHART 0-500 PER CENT

pump governers on the 10 by 8 by 18-in. Wilson & Snyder duplex boiler feed pumps. The boiler operators have been trained to operate the stokers by means of the Bailey air flow-steam flow meter, without reference to the fire as the only inspection doors are 10 or 12 ft. above the boiler room floor and not easily accessible. The only available inspection door is a small one about 3 by 6 in. located immediately over the ashpit so that the operator can determine the height of the ash above the clinker grinders. Armco engineers believe that more efficient operation can be had by using the control in-

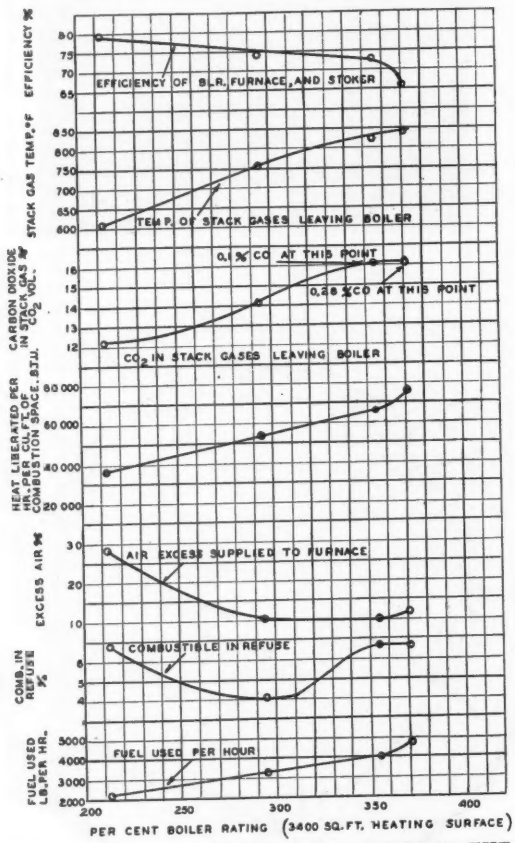

EFFICIENCY %
EFFICIENCY OF B.L.R. FURNACE, AND STOKER
STACK GAS TEMP. °F
TEMP. OF STACK GASES LEAVING BOILER
CARBON DIOXIDE IN STACK GAS % CO2 VOL.
0.1 % CO AT THIS POINT
0.2 % CO AT THIS POINT
CO2 IN STACK GASES LEAVING BOILER
HEAT LIBERATED PER HOUR PER CU. FT. OF COMBUSTION SPACE. B.T.U.
EXCESS AIR %
AIR EXCESS SUPPLIED TO FURNACE
COMB. IN REFUSE %
COMBUSTIBLE IN REFUSE
FUEL USED LB. PER HR.
FUEL USED PER HOUR
PER CENT BOILER RATING (3400 SQ. FT. HEATING SURFACE)

FIG. 6. RESULTS OF BOILER TESTS ON ONE OF THE REVAMPED UNITS. RATINGS REFER TO HEATING SURFACE INCLUDING THE WATER WALL SURFACE

strument than by sight through a flame filled furnace. The boiler meters are set so there is 25 to 30 per cent excess air when the pens are together.

Coal burned is a good grade of washed nut and slack from Armco mines in West Virginia costing $3.10 in the bunkers. A typical analysis on "as fired" basis is:

Fixed carbon	54.31
Volatile	37.23
Ash	6.43
Moisture	2.03
Sulphur (sep. det.)	1.20
B.t.u.	13,752

STEAM VELOCITY REACHED 20,000 FT. PER MIN.

Including fuel, labor and water, the operation cost of steam is about $0.18 per 1000 lb. compared to $0.28 before restokering. An interesting point about the plant is that all the steam, about 2,500,000 lb. per day with a peak of about 110,000 lb. per hr., leaves the boiler house at 175 lb. through a single 8-in. line, the velocity being in the neighborhood of 20,000 ft. per min. This is considerably higher than current power plant practice but quite in line with district steam heating practice, where it is stated the velocity is limited only by the allowable pressure drop. The pressure drop to the distant end of the plant is 50 lb.

Boiler feedwater is taken from the Ohio River, filtered, softened by a Permutit zeolite softener and stored in a 20,000-gal. storage tank. Boilers are equipped with Permutit continuous blowdown system, and Diamond soot blowers and were covered with Johns-Manville Airtight before painting with aluminum paint. A Moffett open feedwater heater was converted to a deaerating heater by the addition of steam coils to the storage tank and a Cochrane vent condenser on the air vent. Because a man is available at all times, no ash conveyor system was installed and ash is wheeled out of the basement in a wheelbarrow.

Cost of the entire power plant change was $81,466.14 of which $8300 was chargeable to the feedwater and induced draft fans, leaving the cost of the three revamped boilers at $73,166.14, about half of which represents the cost of the stokers and water walls installed.

Perhaps the most remarkable part of the construction work was the short time required for the change. The first boiler was off the line, torn down, stokers and water walls installed, brick work completed and boiler back in service in 21 days. The second boiler was out of service only 17¾ days, but the third unit was not rushed as the additional steaming capacity was not needed.

These changes were carried out under the direction of G. M. Coughlin, Combustion Engineer of The American Rolling Mill Co. The plant is operated as well and as intelligently as it was designed and constructed, due partially to careful training both in theory and practice and partially to "Armco Spirit" which pervades and welds together this thoroughly American industrial community.

"IT DOES NOT SEEM UNREASONABLE to expect, provided the tremendous fields continue to be developed in the Mid-Continent areas, that the near future will see huge gas transmission systems extending practically across the continent and linking one system with another for standby service, similar to those now maintained by the power companies," declared Robert W. Hendee, Tulsa, general field superintendent, Oklahoma Natural Gas Corp., in an address before the recent convention of the American Gas Association at Atlantic City, N. J. Only a short time ago, he pointed out, it was deemed an engineering and an economic impossibility to lay a natural gas transmission line of over 100 mi. "But in the last few years," continued the speaker, "the distance natural gas has been transported has increased from 100 mi. to 350 to 500 to 800 and now 1000 mi. and what will be the limit? As long as the market, a suitable reserve and necessary finances are at hand, engineers will provide the needed pipe line and compressor station link between the field and market."

COMBUSTIBLE is arbitrarily defined as the portion of the coal left after subtracting the ash and moisture.

Requirements of Power Plant Auxiliaries

N.E.L.A. Report Outlines the Conditions That Must Be Incorporated to Meet the Needs of the Modern Plant

INITIALLY, STEAM DRIVE was the rule for all auxiliaries in large steam power stations; however, by gradual evolution this has changed until now there is a decided preference for the electric drive. Several factors are responsible for this change: Development of the house turbine with its relatively low water rate as compared with that of small capacity turbines; increased reliability of motors in general and the development of such characteristics as better adapt them to auxiliary drives; comparatively low cost and simplicity of the motor drive; and finally the increasing use of multi-stage bleeding are the principal reasons for the almost exclusive use of electric drive in large modern power stations. Then, too, the present almost universal practice of sectionalizing both the main and the auxiliary power buses, and of using for each important auxiliary (particularly in the case of the larger generators) a multiplicity of units instead of a single large auxiliary unit, has inspired greater confidence in this type of drive by minimizing the likelihood of any extensive shutdown of the electrically driven auxiliaries.

No attempt has been made to compare the relative economies or merits of steam versus electric drive; and although the report indicates a relative decrease in the number of steam driven auxiliaries in most stations, it should be pointed out that one large station, which went into service late in 1926, uses steam drive on nearly all of its auxiliaries.

In order to learn the trend of present practice regarding electrically driven auxiliaries in steam generating stations having units of 20,000 kw. or larger, a questionnaire was sent out. Scarcity of replies in a few instances precludes the possibility of drawing exact conclusions regarding trends but the general requirements as indicated are given below.

Boiler Feed Pumps

On the average, modern boiler room practice will not permit the interruption of the supply of boiler feedwater for a period longer than 1 min. unless the load is immediately dropped. In some cases where boilers are being operated at their maximum capacity, an interruption of the supply of feedwater for even 1 min. cannot be permitted. The use of higher rates of evaporation has necessitated a closer and more rapid control of boiler output, and has not simplified the problem of continuity of supply. The average allowable period of feed-pump outage has apparently decreased in the newer stations. None of the replies to a recent questionnaire indicates that the period may be over 3 min. while the necessity for restricting outages to 15 sec. or less seems to have decreased slightly, possibly as a result of improved control. In additions to stations built before 1924, replies show changes in requirements similar to those of the power stations but to a less degree.

All replies indicate some reserve in boiler feed pumps. There is a marked decrease in the number of replies indicating steam driven reserve pumps and a general decrease in the number indicating full capacity reserve. Only one reply stated that all boiler feed pumps were steam driven. There seems to be an increase in the practice of providing one pump as a spare for two or more operating units, which is probably due to a comparative decrease in pump size relative to the total water requirements. The percentage of replies specifying full reserve capacity in boiler feed pumps, has fallen from 90 per cent, according to an old report, to 50 per cent based on the newer stations. Replies show that steam drive for reserve and operating pumps has decreased noticeably, probably due to the greater confidence in motor drive.

Where motor driven pumps are used, most stations have adjustable speed motors, probably because the operating difficulties with available methods of throttling the pumps are still so serious as to outweigh the advantages of the simplicity and lower cost of squirrel cage motors. It is interesting to note that, both in the stations built before 1924 and in those built subsequently, the adjustable speed installations constitute about 80 per cent of the total reported, whereas speed adjustment is obtained in less than 50 per cent of the additions to old stations. Too much weight should not be placed upon this apparent discrepancy, however, since the report covers only additions to those stations in which changes were made from the original auxiliary practice. A speed range of from 10 to 20 per cent seems to suit the majority of stations. There is little uniformity in the number of steps required except that more than 9 are generally preferred.

Circulating Pumps

Circulating pumps must operate continuously in most central stations if service is to be maintained on the system. The use of higher steam pressures has reduced the effect of changes in vacuum upon output, as compared with turbines operating in a lower pressure range. This reduced effect partially explains the marked decrease in the number of installations in which outage of the circulating pumps must be restricted to 15 sec. or less. Another contributing factor is the increasing use of two pumps per condenser, in which case one may be out of service for some interval without seriously affecting the turbine output. This latter condition is probably the explanation of the ability of some plants to run indefinitely with a circulating pump out of service.

In a number of cases, circulating water is so supplied that full output of the turbines may be obtained in emergency conditions with only one pump in operation. In other cases, the capacity of each pump is such that operation of only one pump results in reduced turbine output, particularly under conditions of warm circulating water. Although there has been little change in

the relative number of stations that provide some spare circulating pump capacity, there is a noticeable increase in the use of full spare capacity. Replies indicate a marked increase in the use of constant speed motors for this service. It appears that the simplicity and lower cost of squirrel cage motors more than offsets the saving due to decreased power consumption to be obtained by speed adjustment.

Condensate Pumps

Under usual circumstances, it is feasible to interrupt condensate pumps slightly longer than boiler feed or circulating pumps; however, according to nearly 70 per cent of the new station replies the average permissible time of outage for these pumps seems to be restricted to 1 min. or less, which is an appreciable decrease in the permissible outage as compared with the previous report.

Replies indicate that more than 90 per cent of the reporting companies provide full capacity reserve in either steam or electric pumps and show a noticeable increase in the use of electric pumps as compared to steam pumps. No noticeable change is indicated in regard to the use of constant speed versus adjustable speed condensate pumps. Approximately ¾ of the installations reported upon have adopted constant speed drive.

Air Pumps

There has been a marked increase in the use of steam jet air ejectors with a corresponding decrease in the installations of motor driven air pumps. Inasmuch as air pumps do not ordinarily need as much insurance against outage as the auxiliaries previously discussed, the present replies place practically no importance upon outages of less than 3 min.; as a matter of fact, all the replies referring to new stations indicate an allowable outage longer than 3 min. with approximately 40 per cent of the replies falling in the class of no duplication. Where motor driven pumps are installed, the use of constant speed motors decidedly predominates.

Draft Fans

Under ordinary conditions, boilers cannot be forced to their maximum output unless the fans are in operation. This is particularly true where pulverized fuel is used and is increasingly the case as higher rates of combustion are applied to stoker fed boilers. There seems to be little change from the previous report in permissible outage, with about 80 per cent of the replies indicating 1 min. or less.

Replies indicate some decrease in the amount of reserve provided; in fact, about 80 per cent of the more recent installations provide no reserve, due largely to the difficulty of installing duplicate units and probably also to the increased reliability of the electric drive. In a few installations, the use of a common forced air duct for several boilers and two induced draft fans per boiler permits a boiler output of 65 to 70 per cent with one fan out of service. The engineer of one large company, who did not specifically answer the questionnaire, states that two-fan equipments are to be installed both for a 75,000-kw. extension to an old plant and for an 80,000-kw. unit in a new plant.

Stokers

No long interruption in stoker operation can be permitted if full boiler output is to be maintained, although longer outages are permissible than in the case of the air supply. Although approximately 50 per cent of the replies permit interruptions of not longer than 3 min. for the stokers, it should be noted that the more recent replies allow a somewhat longer interval than was permissible in the plants covered by the earlier report.

It is not usually practicable to duplicate stoker drives on account of the cumbersome line shafting and clutches involved. Experience seems to indicate that electric drive is thoroughly reliable. Adjustable speed drive still predominates, although one company has installed constant speed motors for this service. Over 80 per cent of the replies provide a speed range of 50 per cent or more. Two-thirds of the replies indicate 20 or more steps in the speed range.

Clinker Grinders

Clinker grinders come in a class of auxiliaries that usually do not require continuous operation and are installed without duplication. Replies reveal the tendency to drive the clinker grinders from the stoker drive and show the growth of stations in which 20 or more steps of speed control are provided.

Crushers and Conveyors

It is obvious that crushers and conveyors may be operated intermittently. This equipment is usually installed with sufficient margin of capacity so that 24 to 48 hr. supply of crushed coal can be stored in the bunkers during an 8-hr. shift. Some stations provide bunker capacity for several days' supply. Replies reveal the growing trend away from duplication in this type of auxiliary and show that a majority of installations fall in the constant speed class.

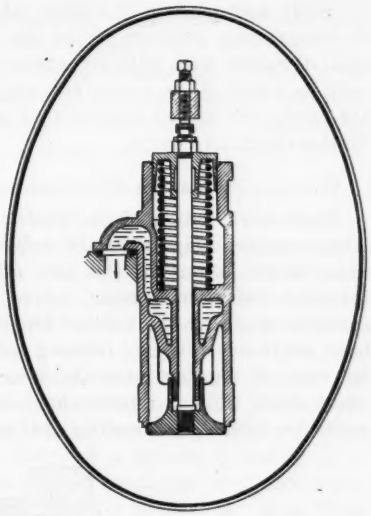
Pulverized Fuel Feeders and Blowers

Increased importance is being placed upon continuity of supply, since the percentage of replies permitting outages of 15 sec. or less has increased from 42 to 80 per cent for fuel feeders and from 33 to 89 per cent for fuel blowers. There is no appreciable change in the duplication of units, with approximately 75 per cent of the installations without any duplication. Adjustable speed motors with a speed range of 50 per cent or more, predominate on fuel feeders, whereas on fuel blowers the use of constant speed motors has increased until approximately two-thirds now have this type of drive. Adjustable speed motors are almost universally provided with a large number of steps in an effort to provide smooth speed control.

Pulverizers

This report includes central and unit pulverizers, which were not mentioned in the earlier edition. On the basis of number of replies received from central stations, large enough to enter the scope of this report, giving each reply a credit of 1, it appears that more companies have installed central pulverizer systems than unit systems; however, based on the total boiler horsepower installed, during 1928-29, 66 per cent of the total boiler horsepower installed using pulverized fuel was equipped with unit pulverizers, rather than central pulverizer systems. Central pulverizers allow outages of 3 min. or longer, whereas with the unit pulverizers, as would be expected, 15 sec. is the maximum permissible outage.

DIESEL ENGINE UPKEEP



PART VIII. PROPER METHODS OF MAINTAINING AIR INLET AND EXHAUST VALVES. EFFECTS OF HIGH LOCAL TEMPERATURES AND HOW TO AVOID THEM. SPECIAL EXHAUST-VALVE-HEAD CONSTRUCTIONS. USE OF VALVE CAGES. WATER COOLING

LENGTH OF LIFE of Diesel engine air-inlet and exhaust valves can be increased greatly by regular and proper inspection and repair, not only of the valves and their seats but of the engine as a whole, as proper functioning of a number of other parts of the engine contributes, in an indirect way, to the length of life of these valves.

PREVENTION MORE EFFECTIVE THAN CURE

As with other phases of maintenance, repair should be undertaken before damage has assumed large proportions. Much unnecessary effort may be spared by acquiring adequate equipment and supplies for repairs and by employing proper methods of repair and of operation of the engine.

FIG. 1. EXHAUST VALVE WITH REMOVABLE SEAT

Low temperature is an important requirement in obtaining good results with exhaust valves. If the combustion is sufficiently rapid to be completed during the early part of the working stroke, the gases inside of the working cylinder will expand almost to atmospheric pressure with a corresponding low exhaust temperature. If, however, the combustion is poor, extending over most of the power stroke, the exhaust gas temperature will be high and even flames may pass the exhaust valves. Conditions become worse when the water jackets of the exhaust valves are coated with scale or if exhaust valves are improperly lubricated.

HIGH TEMPERATURE AND PRESSURE DESTRUCTIVE

While under normal operation the exhaust gas temperature at the valve may be only 800 deg. F., improper combustion may raise this temperature to 1200 or more degrees, while the pressure at which the valves are released mounts rapidly. High temperature tends to burn the valves and seats and high pressure tends to cut the seat due to wiredrawing and erosive action of suspended matter in the gases. High exhaust temperatures may be due also to incorrect valve timing, improper action of fuel pumps or of fuel-spray valves or to excessive overload. Proper control of combustion is, therefore, essential to correct functioning of engine valves.

Uncooled valve cages expand more than the cylinder heads when they heat up, therefore they should not be fastened down with excessive force. Such excessive force also may spring the cage and cause the valve to leak. Cylinder head fracture also may be caused by a badly leaking exhaust valve which heats, abnormally, the cage and cylinder head in the immediate vicinity of the valve. As the temperature of the gases that pass a leaky exhaust valve is about 2500 deg. F. instead of the normal temperature of 800 deg., the unequal expansion which is set up may be severe enough to cause fracture.

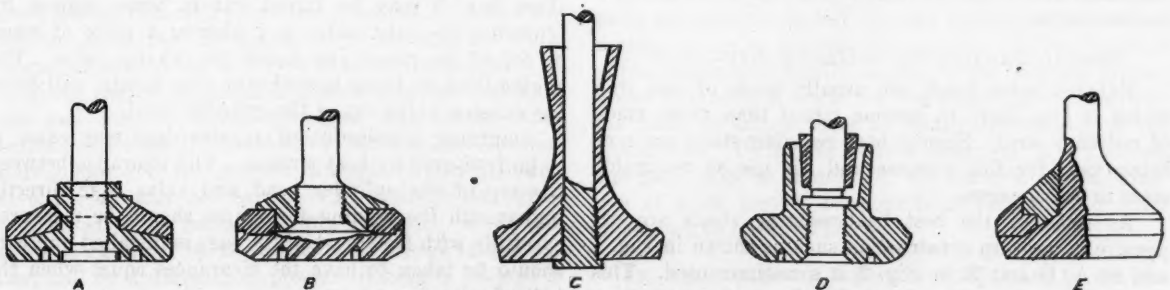


FIG. 2. VALVE HEAD TYPES. BUILT-UP CONSTRUCTION

Wear and pitting of valves, which cause reduction of compression pressure hence loss of power, are principal troubles with exhaust valves due to the greater heat to which these valves are subjected. Inlet valves are rarely overheated because they are constantly cooled by the incoming charge.

Warping of Valves Overcome by Turning Them

Blow-torch action of the fuel-spray in some of the larger engines may cause the exhaust-valve disk to become much hotter on the side adjacent to the fuel-injection valve and cause uneven heating which will result in warping the valve. To counteract this effect, most engineers advocate turning exhaust valves a quarter turn at regular intervals, some every hour, others every shift, while a number hold that the valve should never be turned, contending that once a valve has become seated, it should not be disturbed. New valves may warp when first used, therefore they should be watched carefully or changed after a few days' operation.

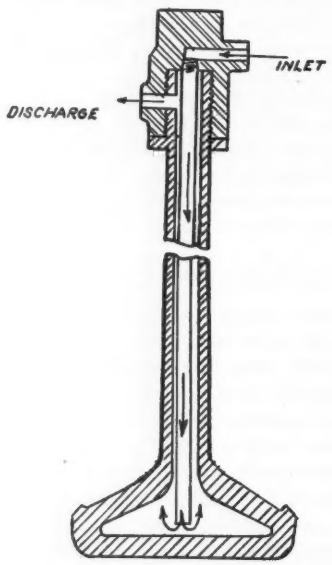


FIG. 3. WATER-COOLED EXHAUST VALVE

Valves for engines having cylinders below 12-in. diameter usually seat directly on the cylinder head. Such construction has the disadvantage of requiring the removal of the cylinder head in order to grind the valves or grinding must be done on the engine. An advantage, however, is the better heat conductivity due to the solid metal while the necessary clearance in cage construction reduces the rate of heat transmission to the cooling water.

Special Exhaust-Valve-Head Construction

Exhaust valve heads are usually made of cast iron which is less likely to become pitted than those made of ordinary steel. Special heat resisting steels are now being used for this purpose and for use as removable seats in valve cages.

As some of the best heat-resisting steels are expensive, a built-up construction such as shown in Fig. 1 and at A, B and E in Fig. 2 is sometimes used. This seat is replaced readily although it is necessary at times to turn them off in a lathe. With engines of large size, some method of cooling the exhaust valve head is necessary. This is accomplished as indicated in Fig. 3.

Since it is difficult to drain the water from water cooled exhaust valves, it is advisable to remove the exhaust valves from the cylinder heads and empty them if the engine is to stand exposed to freezing temperature for a long period.

If the housing of the exhaust valve stem is not bushed, it may be bored out after it has become worn and fitted with a bushing which may be replaced on future occasions of wear at this point.

Use of Valve Cages Reduces Shut-Down Period

Use of cages which are removed easily from the engine, permits grinding the valves at a later convenient time without tying up the engine, a spare valve and cage being used to replace the defective parts. Inlet valves usually seat in valve cages but builders are not unanimous regarding exhaust valves because of the difficulty of lowering the exhaust cage under the cylinder head. The exhaust valve is therefore designed by some of them to allow passage through the inlet-valve cavity after the inlet-valve assembly has been removed. The exhaust valve may then be ground by inserting a pin wrench through the inlet opening.

From the operator's standpoint, the exhaust valve should also be caged because of the greater attention required of this valve. For convenience, valves and valve cages are often made interchangeable.

Air-injection engines over 16-in. bore are usually provided with water-cooled exhaust valve cages as indicated in the headpiece of this article, thus keeping the guide cool and removing some of the heat from the valve and seat. Because of the more severe heat conditions in solid-injection engines some of the smaller sizes of this type have water-cooled valve cages.

Water-Cooled Valves and Cages

With both water-cooled valves and water-cooled cages, the water should be circulated before the engine takes its charge since sudden chilling of the parts may result in fracture. The circulation of the water should be positive and at sufficient velocity to avoid the establishment of pockets. Each time a valve cage is removed it should be examined for scale which, if its presence is indicated, should be removed as explained in Part V of this series. The cage cooling water discharge should be kept below 120 deg. as low temperature improves valve action.

When a valve-cage is installed in an engine, it should be rubbed with a little graphite and oil to avoid sticking. If a cage sticks and cannot be removed easily by using a short bar, it may be forced out in some engines by removing the inlet valve and placing a piece of wood on top of the piston just below the exhaust valve. The engine then, on being barred over very slowly, will force the exhaust valve out of the cylinder head.

Improper installation of a valve cage may cause it to be fractured by heat stresses. The clearance between the top of the cylinder head and valve cage directly underneath the holding-down nuts should be measured carefully with feelers when the cage is installed and care should be taken to have the clearances equal when the bolts finally are set up.

Overloading an engine has about the same destructive effect on the exhaust valve as poor or late combustion but sometimes overloading is necessary. Unequal loading of cylinders due to improper valve adjustment, however, should be avoided and with present standard equipment for indicating exhaust temperatures by the use of pyrometers, this control can be established without difficulty. Dirty spray nozzles, clogged-up flame plates or leaky needle valves, all of which cause poor combustion, make trouble for the exhaust valve.

Leakage Increase Under Improper Attention

Extent of leakage is built up rapidly as follows: A slight leak of hot gas causes the valve to oxidize and form a hard scale. The rate at which this scale forms depends upon the temperature of operation and upon the material of the valve and seat. After this scale has

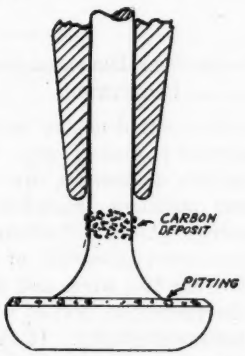


FIG. 4. VALVE AFFECTED BY PITTING AND CARBONIZATION

become thick, it may chip off sufficiently under the repeated blows of the valve, to permit the hot gases to blow through at high velocity thus burning and eroding a groove in the valve and seat.

Leaky Valve Detection

Detection of leaky valves is, in most engines, a simple matter. A leaky inlet valve emits a hissing sound on each compression and power stroke which may be heard by placing the ear close to the intake nipple. The whistling sound increases as the scoring of the valve becomes more pronounced.

Leakage of the exhaust valve may be detected in a similar manner at the try plug in the exhaust pipe but it is more difficult to detect because there is a confusion of noises coming from other sources, hence a little experience is required to single out the hissing sound of the leaky valve. With a little practice it is possible to detect a leak that will cause less than 5-lb. loss in compression pressure. If leakage is to be detected while the engine is running, it is best to have it run idle.

If the engine is placed in such a position that both inlet and exhaust valves are closed and the injection air line valve slightly "cracked" to allow a small amount of air to blow into the cylinder through the fuel-injection valve, the air may be heard flowing through the valve.

Exhaust valve leakage is also indicated, while the engine is running, by the smoky appearance of the exhaust and by a decrease in power. Excessive leakage is indicated by a flow, past the try cock, of bright red sparks. Late burning or poor combustion also may produce red sparks but these are dark.

Peepholes in the exhaust connections close to the exhaust valves furnish a convenient means of checking engine operation. If these have not been provided by the engine builder, it is worth while to put them in.

Pitting and Corrosion

Pitting and corrosion may also cause exhaust valve leakage. Carbon and dirt from the fuel becoming caught between the valve and seat may be hammered into the metal as shown in Fig. 4. Another cause of leakage is due to the valve stem striking the guide, thus preventing the valve from seating firmly.

Protection of the valve stem against the erosive action of the hot gases and the suspended particles in them is accomplished by adding an extension to the exhaust valve in the form of a shroud as shown at C and D in Fig. 2. This shroud overhangs the guide bushing of the valve cage so as to protect the stem from the flowing gases when the valve is opened. It is of some service in preventing the valve from sticking.

Treatment of Flue Gases

By Charles J. Webb

PATENT specification No. 334,660 which, in England, is regarded as of great importance, has recently been published, describing the method of and apparatus for the treatment of flue gases, residual trade gases and the like. The object of the invention, which is in the joint names of the London Power Co., Ltd., and Dr. S. L. Pearce, is to devise means for the treatment of flue gases, fumes or vapors ordinarily discharged into the atmosphere, whereby any obnoxious products may be abstracted from such gases before final discharge, so as to render them substantially innocuous and also to enable any marketable constituents to be readily recovered.

Before discharge, the gases are first led through a chamber containing means for thoroughly saturating them, after which they are washed and scrubbed, the direction of flow being preferably changed between successive operations, so as to facilitate the separation from the gases of any impurities. The gases before discharge and after preliminary treatment are ozonized. At the outlet end of the saturation chamber the gas is submitted to a thorough washing by means of sprays and at the same time the direction of flow of the gases is altered and they are passed through a series of scrubbers of wood, fireclay, metal tubes, or other suitable packings in absorption towers. The gases are then passed through an additional bank of scrubbers, wetted with an alkaline washing water or other fluid for final treatment. The gases are next conducted through eliminator places constructed so as to prevent the emission of free moisture to the atmosphere, finally passing to the chimney proper, where provision is made for the admixture of air with the gases to dilute them as finally discharged to the atmosphere. By means of this invention, it is claimed, flue gases may be treated for the removal and alimination of grits, smoke, compounds of sulphur and other objectionable constituents.

In washing out a boiler, be careful not to wet the stoker arch, as water is injurious to the brickwork.

Protection *and* Metering *for* Three-Wire Circuits

By JOHN AUCHINCLOSS

Switchgear Engineering Department
General Electric Company

IN THE FIRST part of this article, which appeared in the Oct. 15 issue, methods of deriving protecting and metering 3-wire circuits were presented with particular reference to single-phase systems. In this article

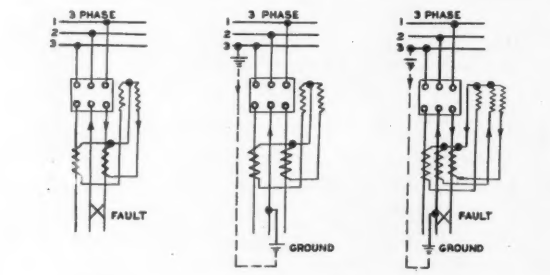


FIG. 19 PHASE TO PHASE FAULT WITH 2-OVER CURRENT UNITS

FIG. 20 DOUBLE GROUND FAULT WITH 2 OVER CURRENT UNITS

FIG. 21 PHASE TO PHASE AND DOUBLE GROUND FAULTS WITH THREE OVER CURRENT UNITS

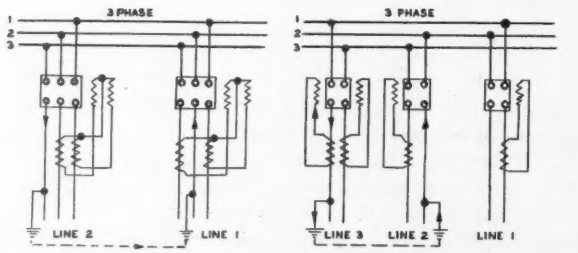


FIG. 22 SIMULTANEOUS GROUND FAULTS ON DIFFERENT PHASES OF 2 THREE-PHASE CIRCUITS

FIG. 23 SIMULTANEOUS GROUND FAULTS ON DIFFERENT PHASES OF 2 SINGLE-PHASE CIRCUITS

FIGS. 19-23. DIAGRAMS SHOWING VARIOUS TYPES OF FAULTS ON THREE-PHASE SYSTEMS

the subject will be treated from the polyphase standpoint.

Polyphase power supplied to most industrial plants is either in the form of three-phase three-wire, three-phase four-wire or two-phase five-wire distribution. Two-phase, three- and four-wire systems seem to be gradually disappearing from the general path of progressive development of the art. In the days when current was generated chiefly for lighting purposes, the two-phase four-wire system was particularly applicable in that the regulation of the two individual phases was comparatively simple. With the increasing application of power for industrial motive purposes and the more economical utilization of copper, however, the older two-phase systems are being rapidly supplanted by the systems mentioned above, with the three-phase greatly predominating.

Three-Phase Three-Wire Delta or Isolated Neutral Protection

On a three-phase isolated neutral system, the sum of the three-line currents is always zero. For this reason, overcurrent protective devices on two of the phases is usually considered sufficient inasmuch as any excess current, such as single-phase, will always appear in two wires. Three-phase overload would, of course, manifest itself in all three of the line wires and should, therefore, actuate both of the protective devices were their operating characteristics exactly alike. If they were not exactly alike, then one at least of the protective devices would isolate the fault.

Where maximum protection is desired, however, it may be advisable to install a total of three protective devices, one in each line. In the case of a single-phase short, there are then two devices actuated by the overcurrent, so that even in the event of the failure of one device the other may still isolate the disturbance. For example, when the circuit is provided with double-pole protection only, a single-phase overcurrent across phase 1—2 in Fig. 19 will flow through protective coil 1 on the breaker, whereas were the breaker provided with three coils (Fig. 21) the excess current would flow through coils 1 and 2. In the first case, if coil 1 functions properly the condition is relieved by the opening of the breaker while, in the second case, if coil 1 should fail then coil 2 would in all probability clear the trouble. Obviously, it is unlikely that both coils would fail at the same time, so that the second arrangement affords double assurance against failure to trip.

Use of three protective coils has the further advantage of affording complete protection against peculiar, albeit unusual, ground coincidences. For example, if, in Fig. 20, a ground should exist at some point on phase 3, either on the bus or on the bus side of the breaker, and before its removal a second ground should occur somewhere on phase 2 towards the load, it is at once apparent that the ground path from phase 3 at the bus to phase 2 at the load short-circuits the current transformer connected in phase 3 and the breaker will fail to open.

If, however, a transformer bank is interposed somewhere between the bus and the source of power, the protective devices on the source side of the bank will prob-

ably clear the trouble, but unfortunately at the expense of shutting down everything connected to this particular bus; whereas, were the feeder breaker equipped with three-over-current devices (Fig. 21), it would immediately respond to the excess current in its own section of phase 2 and confine the shutdown to its individual circuit only.

Obviously, the worst condition under which this simultaneous ground coincidence could arise is where the bus in question is fed directly from a generator which is not provided with over-current protection. In this case, there is nothing to interrupt the excess ground current except the fusing of the smallest section of the intervening conductor.

The foregoing would seem to constitute rather a strong argument in favor of equipping at least the service breaker with three over-current units.

When relays are employed in place of direct-acting

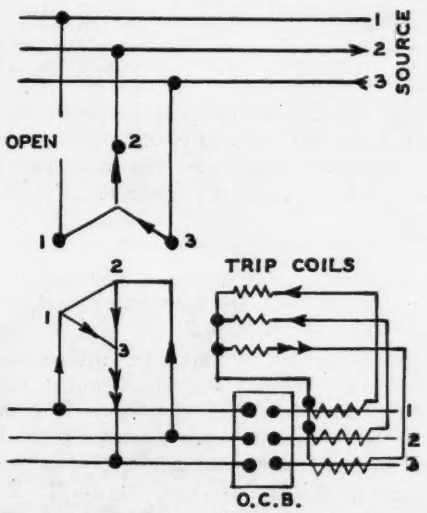


FIG. 24. SHOWING DOUBLE CURRENT IN SECONDARY LINE WITH PRIMARY LINE 1 OPEN

trip coils, the use of three of them on a three-phase, three-wire circuit has an additional advantage in that each relay may be tested and calibrated individually without removing the protective features of the remaining two. By this means, all three relays may be tested in turn, during which time the circuit is still provided with a high degree of protection.

When two-coil protection is provided, however, it is most important that each coil be located in the same phase throughout the system, usually in phases 1 and 3. If this practice were not followed, it would be possible for two simultaneous grounds to arise which will not operate either protective device. For example, if, in Fig. 22 simultaneous grounds should occur on phase 2 of line 1 and phase 3 of line 2, a short circuit would take place across phase 2—3 of the system. From the figure, it is clear that the current arising from this short will not actuate any of the trip coils, whereas, were both sets of current transformers located in phases 1 and 3, line 2 would open and interrupt the short-circuit current.

In a similar manner, it may be shown that if three single-phase circuits are fed from a three-phase bus, one of the circuits, if they are distributed on the bus, must be provided with two trip coils. This is illustrated in Fig. 23 where obviously simultaneous grounds on phase 2 of line 2 and phase 1 of line 3 would not be relieved unless protection were provided in both poles of line 3.

Before leaving the subject of protection for a circuit fed from a delta-connected system, a rather interesting situation arises when the delta is derived from transformers whose primaries are connected Y, with isolated neutral, as shown in Fig. 24. In the event of an open circuit developing in one of the primary lines, say line 1 in the figure, the primary current then becomes single-phase across primary lines 2 and 3. Since, under this condition, the transformer primary winding connected to line 1 is open, its secondary winding becomes simply a high impedance across the secondary lines 1 and 2, and what was formerly a three-phase load on the circuit connected to the delta side now becomes a single-phase load with line 3 on this side carrying the sum of currents in lines 1 and 2. This excessive current may cause overheating in the secondary line conductor No. 3 and it is, therefore, necessary that this conductor be protected by an overcurrent device. Since it is obvious that primary lines 2 or 3 might just as readily become open as line 1, with corresponding excessive currents in delta lines 1 or 2, it is at once apparent that on a delta circuit of this kind an overcurrent device in each delta line, or a total of three such devices is imperative.

Metering

On any three-phase delta or isolated neutral system, the power may be measured in the form

$$\sqrt{3}\,E\,i$$

or

$$3\,e\,i$$

Where E and e represent respectively the voltage across phases and the voltage to the artificial neutral of the system, and i is the current.

The former is measured by the 2-wattmeter method, or two single-phase wattmeters on a common totalizing shaft. The latter form requires three single-phase meters, or their equivalent, with an artificial neutral derived from the three equal impedances of their potential coils. When the neutral is artificial, any other burden on the secondaries of the potential transformers may unbalance these impedances, and a resultant shift in the position of the secondary neutral point will affect the accuracy of the meter. Due to its lower cost (two discs only) it may be stated that for general purposes the two-wattmeter method is most commonly used on isolated neutral systems, although there are undoubtedly conditions of extremely low power factor, such, for example, as may be encountered in measuring the energy of a synchronous condenser, under which the two-wattmeter method is at a slight disadvantage. Normally the condenser operates around zero power factor so that the torques of the two elements of the meter almost exactly oppose each other. A slight unbalance of the elements is consequently considerably exaggerated in the total reading. Under these conditions, the three-element meter is preferable inasmuch as, regardless of the power factor, the torques of its three elements are always in the same direction.

Editor's Note.—This is the second of three articles on the subject by Mr. Auchincloss. The third will appear in a subsequent issue.

High Speed Protective Relays*

MODERN TYPE OF RELAYS, THEIR PRINCIPLES AND APPLICATION TO VARIOUS CONDITIONS. BY L. N. CRICHTON†

DURING THE past year or so, studies of system stability have been made with the view of determining the conditions under which large amounts of power can be transmitted without danger of the equipment falling out of step under fault conditions. With high-speed relay and breaker operation, more power can be sent over a transmission line without losing synchronism on faults; insulator damage due to flashovers will be negligible; the damage to conductors will be practically eliminated, and interference with communication circuits reduced.

NORMAL FREQUENCY SYSTEMS

Since high-speed breakers require from 4 to 8 cycles to open the circuit, high-speed relays, in order to keep

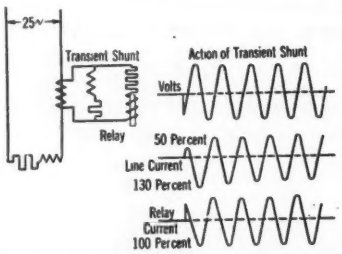


FIG. 1. TRANSIENT SHUNT AND LABORATORY TEST RESULTS

Showing that the shunt diverts the d.c. compound from the over-current relay in that the first half cycle of current is the same value as the sustained current.

the total clearing time within the required limits, must operate in one cycle or less on a 60-cycle system. Many relay operations will be less than one cycle,—possibly even below ¼ cycle.

High-speed relays may be constructed to operate on any of the present well-known principles, such as the impedance principle, the current balance principle, etc., and may employ either a mechanical structure or may make use of thermionic or gas filled tubes. A difficulty is that the transient values of short-circuit current may vary through a wide range depending upon the point on the voltage wave at which the trouble occurs.

A simple overcurrent relay may be compensated by means of a "transient shunt," shown in Fig. 1, so that its performance will be uniform no matter at what point of the voltage wave the short circuit occurs. This shunt is made up of resistance and reactance and is so proportioned that it carries the d.c. component of the unsymmetrical current to flow through the relay.

It is necessary to make sure that a directional relay integrates the conditions existing in the power circuit over a considerable period of time. Except at unity power factor, the flow of power is always alternating so that the direction of trouble cannot be instantaneously determined.

DIFFERENTIAL RELAYS

On parallel lines, differential relays might be used and can easily clear the majority of troubles by opening the breakers simultaneously at each end of the line. It is well recognized, however, that when trouble is close to

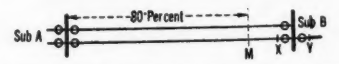


FIG. 2. ILLUSTRATING THE DIFFICULTY THAT RELAYS AT SUB. A WILL HAVE IN DISTINGUISHING BETWEEN TROUBLE AT X AND Y AND IN DETERMINING WHETHER THE POINT X IS ON THE TOP OR BOTTOM LINE

one bus (X Fig. 2), the relays at the other bus cannot tell which is the bad line and must wait until the closer relay has operated before they can act. This is what has been called "sequential" operation.

IMPEDANCE RELAYS

The impedance relay will not eliminate sequential operation because (referring to Fig. 2) the two impedance relays at Substation A cannot distinguish trouble at X any better than can differential relays. Furthermore, a relay at substation A cannot distinguish between a short circuit at X and one at Y is these two points are both close to the bus bars. It is therefore necessary to limit the operation of relays at Substation A to a zone extending from the relay to M. This zone will be approximately 80 per cent of the length of the

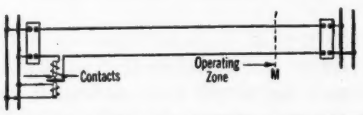


FIG. 3. THE SIMPLE, HIGH-SPEED, IMPEDANCE RELAY

line section but it will vary depending upon the nature of the fault and the accuracy of the relay.

The fundamental design of this type of relay (Fig. 3) is simple. A current coil attempts to close the contacts but is restrained by the voltage coil. The two coils are so proportioned that they balance each other when a short circuit occurs at the point M. If the trouble is closer than that point, the relay will operate; if it is farther away, the relay will not operate. This device is instantaneous in the usual meaning of the term but of course it will operate faster when the trouble is close to it.

DIRECTIONAL ELEMENT

Conventional induction type directional elements would be too slow for high-speed relays, but a modification has been made which will do fairly well if the voltage can always be kept above 20 per cent of normal. For unbalanced short circuits, this is satisfactory if the

*Abstract of a paper presented before the American Institute of Electrical Engineers.

†Meter Engineering Dept., Westinghouse Electric and Mfg. Co.

customary connection is used which permits at least one relay of a set to obtain its voltage from an unaffected phase. For three-phase faults, this type of directional element will not be satisfactory, particularly because three-phase faults are most serious and must be cleared with the highest possible speed. One of several methods which has been suggested for overcoming this trouble is to drive continuously a small synchronous motor having a sufficient flywheel effect so that it can keep its proper phase position during the line disturbance (Fig. 6). Of course this motor will not stay in step for any great

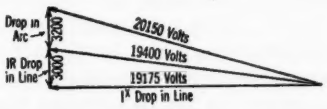


FIG. 4. EFFECT OF RESISTANCE OF AN 8 FT. ARC ON THE IMPEDANCE OF 50 MI. OF SHORT CIRCUTED 220 KV. LINE

Insulators on all 3 phases assumed to have flashed over simultaneously.

length of time but we are concerned with only the first few cycles.

Reactance Relays

The effect of resistance at the point of fault in shortening the operating zone is frequently mentioned, but a number of years' experience with relays of the impedance type indicates that this is not serious, at least for short circuits. In a short circuit, as distinguished from a ground, the only resistance can be that of an arc. A remarkable set of tests made by P. Ackerman several years ago showed that long arcs of heavy-current values have a potential across them of about

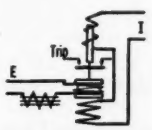


FIG. 5. SIMPLE REACTIVE RELAY

The balance point is where $I^2 = E\ I \sin \phi$ which, simplified is $I = E \sin \phi$.

400 v. per ft. Some unpublished tests made in Germany gave a potential of 360 v. per ft. If the short circuit is close to the relay, this arc voltage will be too small to prevent the relay from operating; and if the trouble is near the far end of the operating zone, its vectorial relation at right angles to the reactance of the line will be such that it will not seriously change the length of this zone.

Of course, if the arc is not interrupted promptly, it will increase in length with a consequent increase in the voltage across its terminals. This increase in arc voltage will reduce the current somewhat and this current reduction may in turn increase the resistance of the arc, this circle of effects continuing until the arc voltage becomes a large fraction of the normal line voltage. But this requires time. Tests on two different power systems have shown that the arc remains stable and of low resistance for five or six cycles.

The same argument cannot be so easily applied to ground faults because it is conceivable that the earth has considerable resistance at the point where the fault occurs. It is possible to construct a reactance relay for ground protection, which will nullify the effect of the fault resistance to a large extent. A relay utilizing the reactance principle can be made in a manner similar to the impedance relay except that the restraining coil, instead of being operated by voltage, should be constructed as a wattless component indicator (Fig. 5). For a single-phase system, this is easy to apply but because of the different kinds of faults which occur, difficulty is encountered on a three-phase system.

The Use of Thermionic and Gas-Filled Tubes

Because of some obvious advantages, the use of devices of these types has been suggested by many engineers. Work along this line is progressing rapidly and there is no reason why impedance relays, including directional elements, should not be constructed of such material.

The tube is faster than any mechanical device having the same burden on the current and potential transformers. Because of the time constants of the various

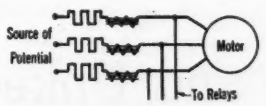


FIG. 6. MOTOR SO CONNECTED THAT IT WILL MAINTAIN VOLTAGE ON THE POWER DIRECTIONAL COILS OF A RELAY EVEN THOUGH THE POTENTIAL ON THE LINE MAY BE REDUCED TO ZERO

electrical circuits, it will probably be difficult to obtain the extremely high speeds which might be expected. But then, speeds much below 0.3 cycle appear difficult to attain because of the time required by the directional element.

High-Frequency Schemes

The only apparent methods of securing simultaneous operation of the breakers at each end of a section of line under all locations of fault is by means of some high-frequency scheme.

Some of the high-frequency schemes which have been suggested will increase the speed of relay operation; others will simply make sure that the breakers at both ends of the line will be opened simultaneously at the speed which may be attained by normal frequency relays. A superimposed scheme has been suggested, carrier current is in use and several proposed schemes are being investigated. Consideration has been given to the use of both moderate frequencies of the order of 500 cycles and carrier current frequencies of from, say, 200 to 100 kilocycles.

Superimposed High Frequency

The superimposed high-frequency scheme described by L. R. Ludwig before the American Institute of Electrical Engineers, June 25, 1928, promises to become of considerable importance. The method is to superimpose a high frequency on the power system at various points —probably at every place where there is a power transformer—and depend upon the short-circuiting of this

high-frequency circuit to sectionalize the transmission line. The reason for using the high frequency is that it can be more cheaply blocked out of line sections than can the normal frequency.

For a three-phase system, a three-phase generator may be used so that short circuits between wires as well as short circuits to ground can be isolated. Directional relays can easily be provided on such a system although they will not usually be required.

Carrier Current Schemes

All of the carrier current schemes that have been suggested make use of some characteristic of the fundamental current for their operation or else they depend upon normal frequency relays which send out a high-frequency impulse to the other end of the section. They are all equivalent to the use of pilot wires. Various frequencies have been suggested ranging from 500 cycles to 100 kilocycles but the difference in frequency does not materially affect the principles involved; neither does it appear that any particular range is less likely than another to be interfered with by the power arc disturbance which occurs during the trouble. The advantage of a higher frequency seems to be that it is somewhat easier to block out of circuits where it is not desired.

Power Arc Disturbances

There is no doubt but that when considering the questions of high frequency relay the arc which occurs at the point of faults must be given serious thought. Often there is no way to send a carrier impulse to the next station except over the line which is in trouble. It is conceivable also that this arc may send a false signal. The difficulty is that any shock to a tuned circuit will cause it to oscillate and this shock may be applied to the tuned circuits of receiving sets over a large part of the power system. This may result in a tripping impulse being improperly given. It will not help much to have the carrier running continuously and interrupt it as a signal, because the arc disturbance may be of such a nature that the stoppage of the carrier will not be detected.

Apparently the answer to this difficulty is to raise the power level. By this is meant to increase the amount of power used by the carrier equipment to such a point that it will not be seriously influenced by the disturbance set up at the point of fault.

Care and Upkeep of the Refrigeration Plant

Care of Compressor and Condenser. Upkeep of Refrigerant. Tools and Instruments Necessary in Maintaining Plant in Good Operating Condition

UPKEEP AND MAINTENANCE in a refrigerating plant divides itself, naturally, into two main elements, first, upkeep of the mechanical and electrical equipment, that is, the compressors and motors, condensers and expansion coils, and second, the upkeep of the refrigerant itself. While the necessity for the proper upkeep of the mechanical equipment is generally recognized, that of the latter is quite as important but is not so generally given the required amount of attention. Of course, the proper upkeep of a plant embraces other things as well as those listed above. For instance, there is the matter of "upkeep" of personnel, that is the proper management of the operating force. The operating force is quite as much a part of the plant as the machinery and if the confidence of the men who operate the plant is established, if they are taught to do their work efficiently and if their morale is maintained at a high standard by fair dealings, the maintenance of the mechanical side of the plant will offer no serious problems.

It is not the purpose of this article to discuss the principles of management of the operating force, but we will take the time to point out that employes are human, at least most of them are, and if they are treated as human beings, they can be made to accomplish much. Efficient performance should, of course, be a requisite and only men who possess the possibility of becoming efficient members of the force should be retained. There are those, who, despite all the opportunities afforded them and notwithstanding all the assistance and privileges granted them, "do not care." Such men cannot be retained. It requires careful study in arriving at correct conclusions in reference to individuals of the operating force in order that justice may be done, and we must keep in mind always in cases of this kind that we are dealing with men, not with machines and that the laws governing one do not apply to the other. The problem of handling men is an art in itself at which some are more proficient than others.

Compressor Upkeep

Among the various pieces of mechanical equipment in the refrigerating plant, the compressor is, perhaps, the most important and upon its efficient performance often depends the economy of the plant. So, the first thing an engineer of an ice plant should know is that his compressors are working at their highest possible efficiency. There is only one absolutely sure way of knowing this and that is by means of an indicator. A compressor may appear to be in good working order and to all appearances may seem to be operating at its highest efficiency, yet because of leaky valves and pistons, may be operating inefficiently.

The capable engineer, therefore, will make it a regular practice to take indicator diagrams from his compressors. Comparison of these diagrams over long periods will promptly indicate any serious loss of efficiency which may not be evident by the action of the machine. Once the picture of the correct indicator diagram has been firmly impressed on the men in charge of a given machine, it is simple to note any difference in new diagrams and the cause will usually be determined easily after a study of the diagram.

Among the essential things in the operation of the

compressor is lubrication. In buying oil for use in an ammonia compressor it is very important that the selection be made with due regard to the service involved and the operating conditions that will be encountered. Lubricating oils for service in an ammonia compression system require consideration of their pour test, fire point and viscosity for it is these characteristics which will be indicative of the extent and degree of success with which any lubricant will function.

An essential requirement of lubricating oil used on refrigerating machinery, is that it shall remain fluid at the lowest temperatures to which it may be subjected during operation. In other words, oils having a low congealing point should be selected.

Low pour test, however, is not the only important characteristic. It is essential, also, that the oil have a high enough flash point at the pressures involved to insure against being carried over too rapidly at the discharge temperature.

Even with the best oil, however, only the smallest amount possible should be used, since an excessive oil coating on the cylinder walls and on the interior of the coils will reduce capacity.

Particular care should be given to the oiling system of an ammonia compressor stuffing-box. The oil lantern found in the center of practically every ammonia compressor stuffing-box serves two purposes: first, it provides a liberal oil supply for lubrication of the piston rod and also partly helps to seal the packing against the passage of gas.

The stuffing-box should be watched carefully for signs of trouble since it is a vulnerable point and is more likely to develop trouble than other parts of the machine. It often requires close adjustment. Most of the difficulty experienced with stuffing-boxes is due to changes in temperature. For this reason, it is important to maintain machine temperatures as uniformly as possible.

Close attention must be given the piston rod and the cylinder walls. The rod should be maintained smooth and of exactly the same diameter throughout its length. If for any reason it becomes scored or smaller in diameter at one point than another, it should be removed and turned down. The cost of this will be far less than the cost of ammonia wasted and cost of extra packing, if the machine is operated for any length of time with a damaged piston rod.

Crosshead and crosshead shoes require periodic adjustment. By removing the packing from the stuffing-box and turning the machine over slowly, any misadjustment of the crosshead shoes will be plainly evident. The crosshead shoes should be adjusted until this condition is rectified.

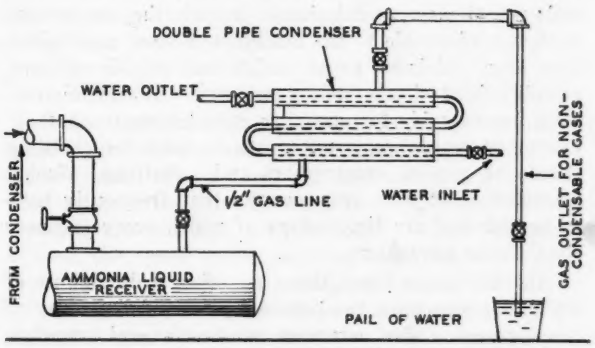
Condenser Maintenance

The function of the ammonia condenser is to remove the head taken up in the evaporator side of the system and that added during the process of compression and to change the ammonia back to a liquid state. Condensers, of course, are of various types and the maintenance requirements differ accordingly. There are certain requirements, however, which apply to all types and these should be adhered to if efficient performance is expected. The principal item regarding condenser operation is cleanliness. Unless the condenser tubes and heat transmitting surfaces are kept clean and free from scale, there will be a decrease of production and trouble may be encountered with the compressors.

Double-pipe condensers may be cleaned of scale formation by means of a round, stiff wire brush attached to the end of a ½-in. pipe and pushed through the tubes. If the scale is very hard or thick, it can be removed by means of a rotary tube cleaner or a drill fastened on the end of a piece of pipe and driven through the condenser. The condenser should always be washed thoroughly after it has been cleaned before the return bends have been replaced. Shell and tube condensers can be cleaned while in operation in a similar manner, by removing the water distributing device from one tube at a time, punching the tube and replacing the thimble or ferrule.

Removal of Noncondensable Gases

Noncondensable and foreign gases in a system mean waste of power. In many plants from 10 to 15 per cent of the power used could be saved if the noncondensable gases were removed from the condenser and receiver.



ARRANGEMENT FOR THE CONTINUOUS REMOVAL OF NON-CONDENSABLE GASES

Foreign gases accumulate in different ways. Noncondensable gases are formed by the decomposition of oil and ammonia and their presence is usually indicated by a high condenser pressure. Under normal conditions, this pressure should be the pressure corresponding to a condensing temperature 10 to 15 deg. above the water entering the condenser.

Every installation should be provided with a means for removing the noncondensable gases from the system. In some of the older plants, purging connections were made only at the top of the condenser, but recently it has been shown that in most cases the noncondensable gas is carried down to the liquid receiver by the velocity of the ammonia through the condenser.

It used to be customary to remove the noncondensable gases by means of a hose attached to the purge line and inserting the end of the hose in a pail of water, and this method is still in use. By opening the purge valve slightly, the noncondensable gases bubble up through the water. When ammonia begins to escape, it is absorbed by the water, producing a cracking noise similar to that produced by steam discharging into a vessel of water.

While the method described above is satisfactory, a more economical and effective method of purging is by the use of a noncondensable gas separator, an apparatus consisting of an evaporator coil inside a cylinder. The

cylinder is first partly filled with liquid ammonia which is cooled to near the temperature of the low-pressure gas. Then the noncondensable gases are allowed to percolate up through the cold liquid ammonia and escape through an automatic valve on the top of the cylinder. Any ammonia that is mixed with the gases is condensed out in passing through the cold liquid which is under a pressure slightly below that in the condenser.

Noncondensable gas can be removed also by means of the method shown in the accompanying diagram. While the plant is in continuous operation, the valve on top of the receiver is left wide open and the valve at the top of the small condenser is cracked just enough to let the gas escape in the form of bubbles into the water in the pail.

Tools and Instruments

No plant can be maintained and operated in the proper manner unless there are available certain essential tools and instruments. While these will vary somewhat in accordance with the type of plant, in general the tools found most useful should include the proper size wrenches adaptable to the machines, a steel machinist's type level, thickness gages, inside and outside calipers, plumb bob, steel tape and piano wire. Inside micrometers are valuable for checking cylinder wear. A tachometer or revolution counter can be used for checking speeds of motors, compressors and shafting. Socket wrenches to fit nuts or capscrews that frequently have to be removed are time savers of which every engineer should take advantage.

In addition to these, there are other tools, the use of which depends upon the personal likes and ingenuity of the engineer. Offset extension handles for end wrenches, forged screwdrivers with right-angled handles, special packing screws and packing pullers, special chisels for chasing out oil grooves in bearings, piston rod wrenches, piston ring clamps and guides, metal scrapers and valve wrenches, all prove extremely useful at times.

Instruments necessary again depend upon the size and type of plant. First and foremost among these are thermometers. Temperature and its proper control is of great importance in the refrigerating plant and the thermometers used should necessarily be accurate and graduated through the desired range so that accurate readings may be taken. Thermometers are of two general classes, indicating and recording. Pressure gages are probably next in importance. These also may be either of the indicating or recording type. Pressure gages require testing with a dead weight testing outfit at least once a year.

For low-pressure readings, a mercury tube is most accurate and in the refrigerating plant this type is useful when installed on the evaporating side of the system.

The engine indicator has already been mentioned as being valuable in the diagnosis of compressor trouble and to maintain compressor efficiencies. In using the indicator on an ammonia compressor, care should be used in making connections. Contrary to steam engine practice, the indicator should be connected as close to the cylinder end as possible and one end only taken at a time. This is to avoid false diagrams due to reëxpansion of trapped gases in the indicator piping.

Flow meters must be provided for accounting for the quantities of water, brine and ammonia pumped. For the measurement of brine condensing water, the Venturi meter is used quite generally. It is also used on the liquid ammonia lines to the various evaporators of the system. By the use of the meter, a rate of ammonia flow can be established by practice which will be just sufficient to maintain correct operating conditions, and this rate can be maintained permanently. The meter serves as a continuous check on the compressor and evaporator, since neither can lose capacity without its becoming evident at once.

For the testing of brine, a salometer should be provided. This is an instrument built on the order of a hydrometer and graduated to read in per cent salt. When the brine is tested, the salometer readings may be checked with tables as to its freezing point. Care should be taken so that the strength of the brine is such that it will not freeze, as even a slight coating of ice on the coils or tubes retard the heat transference considerably.

Ammonia may be tested by means of a test tube or bottle holding 100 c.c. and graduated to a small neck in the bottom in divisions of one c.c. If this tube is filled to the 100 c.c. mark and the ammonia then allowed to evaporate, the resulting residue will indicate the amount of impurities present. While evaporation is taking place, the tube should be immersed in cold brine, since if the boiling of the ammonia is too violent, some of the impurities may be driven off with the vapor, rendering the test incorrect. The boiling temperature may also be checked at this time.

Matthew S. Sloan, president of the New York Edison Co., the Brooklyn Edison Co., and affiliated electric companies, has announced that the 145,000-hp. sixth unit of the Brooklyn Edison Co.'s Hudson Avenue Generating Station has been placed in operation, bringing the total capacity of the station to over 600,000 hp. The entire unit, including the steam turbine, condensing equipment and electric generator, installed with all its electric and steam auxiliaries, cost approximately $7,000,000. This unit is of the same capacity and similar in its main features and equipment to the fifth unit in the same station, which was placed in operation in September, 1928. Both generators were built by the Westinghouse Electric & Manufacturing Co. Mr. Sloan said that the remaining space in the Hudson Avenue Station would be occupied by two 215,000-hp. units, recently ordered from the General Electric Co. When these units are installed, the capacity of the station will be more than one million horsepower, making it the greatest concentration of power anywhere in the world.

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385 days' continuous running looks like a notable record even in this age of marathon contests. A 365-hp. Diesel engine in the plant of Elko-Lamoille Power Co. at Elko, Nev., was started at 4:15 p. m. on Aug. 14, 1929, and ran without shutdown until Sept. 3, 1930, at 4:15 p. m. As everything was reported in good condition, apparently it might have gone on longer but presumably the engineer thought it might need looking over. At that, this was no novice performance, as this same Busch-Sulzer engine, which was 8 yr. old, had previously made non-stop runs of 90, 142, 211 and 272 days. Evidently, Ray G. Chester, the engineer, believes that a faithful servant is worthy of good care.

Multispeed Motors for a Multitude of Uses

TWO, THREE AND FOUR-SPEED, SPEEDS AVAILABLE, SPEED CONTROL, EXAMPLES OF APPLICATIONS. BY R. H. ROGERS*

USE OF MULTISPEED motors is steadily increasing particularly in the machine tool and woodworking machinery fields; also, they are found so useful in many industries where they are applied in a variety of ways that lines of "standard" ratings are listed by manufacturers and numerous special combinations are built for special applications.

Multispeed motors are alternating-current motors having two, three or four fixed speeds, widely spaced, at which they may be operated. The speeds are selected by the operation of a pole-changing switch usually of the drum type. Induction motors of both the squirrel cage and wound-rotor types are frequently arranged for multispeed operation and synchronous motors are sometimes arranged for two speeds. Induction motors with a single stator winding can be designed for two speeds by bringing out leads and arranging the polar grouping so that the switch can select either the minimum number of poles or double that number, Fig. 1. The resulting speeds will be in ratio of 2:1 as, for instance, 1200/600 or 1800/900 r.p.m. For three or four speeds, a double winding is required, each part arranged as for a two-speed motor. The switch can then select the minimum number of poles of one winding, the minimum of the second winding, then double those numbers in order. This results in speeds such as 1800, 1200, 900, 600 r.p.m. Three-speed motors are inherently four-speed units which do not make use of the fourth speed. Two-speed motors, where the speeds are not in the ratio 2:1, necessarily have two windings.

*Industrial Engineering Department, General Electric Co.

SPEED CHANGES FOR WOUND ROTOR MOTORS

Wound rotor induction motors arranged for multispeed operation are subject to speed reduction by the introduction of resistance in the secondary (rotor) winding and this procedure results in a fairly uniform speed service through a wide range. When resistance is used, the speed varies with load and the more so as the resistance is increased and speed lowered. The multispeed feature, however, gives low speeds with less variation than would be the case with a single-speed motor. This is because increasing the number of poles sets a new low synchronous speed and a small amount of resistance will give the desired speed change that would otherwise require a great amount. It should be noted that secondary resistance has little effect on the motor speed at no load. The rheostatic losses of slow-speed

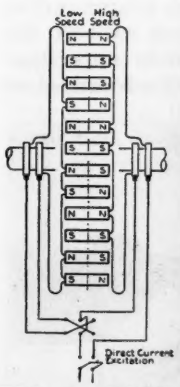


FIG. 1. POLE CHANGE METHOD FOR TWO-SPEED MOTOR

FIG. 2. CONTROL PANEL AND TWO-SPEED INDUCTION MOTOR WITH BRAKE FOR SKIP HOIST

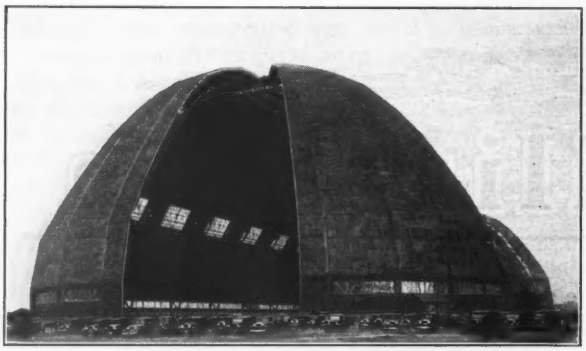


FIG. 3. 450-T. DOORS OF GOODYEAR-ZEPPELIN AIR DOCK SWUNG BY 2-SPEED MOTORS

operation are also much less under these conditions, since there may be no resistance required or at most only a small amount.

On the other hand, squirrel cage induction motors and synchronous motors can be operated only at the fixed speeds indicated by the number of poles and the frequency of the energy supply.

Fields of Application

Multispeed motors have a great variety of popular applications, as the comparatively low cost and simplicity of these units lead to their use in place of adjustable speed motors. Undoubtedly for many applications of motors having wide ranges, motors having a few fixed speeds would answer just as well. It is difficult to classify such applications but they may be roughly grouped as follows:

(a) For driving equipment which requires different outputs by seasons or between day and night. In this class would fall pumps, blowers and feeders.

(b) For use with systems which provide for adjustable frequencies through a range that would span speeds between those obtained by pole changing. A typical example is found in ship propulsion where the frequency is changed by an adjustable turbine governor for minor speed changes and major changes are made by the polar regrouping in the propulsion motor.

(c) Where it is necessary to bring heavy inertia loads up to speed gradually or to stop and spot them without excessive shock or braking. For example, multispeed motors are used on rotary car dumpers, blast-furnace skip hoists and geared elevators.

(d) Where the driven equipment has two distinct duties requiring different speeds. An example is found in oil well equipment where a low speed is used for pumping and high speed for servicing the well, such as pulling the pump, bailing, pulling and setting casing pipe.

(e) On machinery having wide range of output or wide range of work on single output. This class is illustrated by steel rolling mills which on occasion may roll the first passes at slow speed and finish passes at high speed. Other rolling mills use two or more speeds to cover a wide range of merchant products.

Ratings and Characteristics

Four-speed squirrel cage motors for 1800/1200/900/600 r.p.m. are readily available from 1 to 40 hp., for 220, 440 and 550 volts at 60 cycles. Constant horsepower units range from 1 to 20 hp. and constant torque motors from 2 to 40 hp. The constant horsepower type is applied on machines or for other apparatus where the horsepower remains fairly constant and the torque increases as the speed is decreased. The constant torque type is the more often applicable since, as a general thing, the torque required falls off with speed. Two-speed squirrel cage motors may be considered standard in speed ranging from 1200/600 to 720/360 r.p.m. and for horsepowers from 10/3.5 to 150/50. Two-speed constand horsepower units are rated 1 to 25 hp. in either 1800/900 or 1200/600 speeds.

At the higher speeds, the motor slip will be from 2 to 5 per cent, at low speed from 4 to 8 per cent. Starting current is much less at the low speeds, being about two-thirds of that at double the low speed. Starting torque is reduced 10 or 12 per cent at the low speeds but is still more than normal full-load running torque.

Other speeds and horsepowers in squirrel cage motors, multispeed wound-rotor motors and two-speed synchronous motors require special consideration on the part of the manufacturer.

Specific Applications

Machine tools and woodworking machines utilize numbers of multispeed motors. The main working motors are generally of the constant horsepower type while feed motors are of the constant-torque type. Multiple drill presses use a four-speed motor for each chuck to accommodate drills of various sizes. On other machines, speeds are selected to suit the size of work being turned out and to suit the hardness of the material being worked. An unique application is found in machine and woodworking shops where multispeed motors drive generators to give various frequencies. For instance, a four-speed motor makes five frequencies available by dodging the 60-cycle supply frequency. There may be one frequency below normal, then normal from the supply, and three frequencies above normal. These circuits may feed a single multiple-motor tool or a group of tools applied to the same class of work.

Dough mixers in bakeries make excellent use of two-speed motors. The preliminary mixing of dry ingredients and liquids is made at the low speed. The kneading is then carried out at the high speed, a large part of the mechanical energy being converted to heat the dough. A typical unit shows an increase in temperature of one degree per minute and the operation is carried on

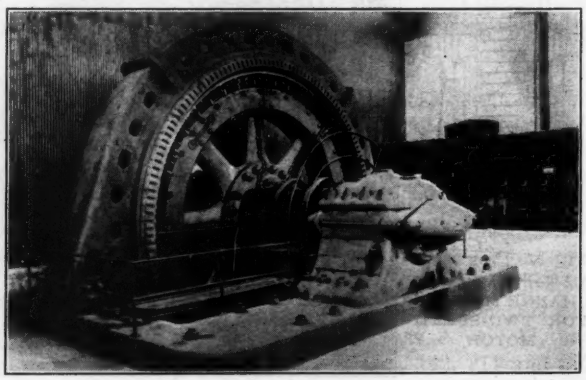


FIG. 4. THIS 6500-HP., 6600-V., WOUND ROTOR MOTOR OPERATES A 60-IN. PLATE MILL. RUNS 107 OR 53 R.P.M.

until the required temperature is reached. If the machine is stopped too soon and has to be restarted to raise the temperature a few degrees, the slow speed is used for starting. This requires high torque for a few seconds to raise the batch over center and through the breaker bar, hence the low-speed rating is on a high torque, short time basis.

Flat work ironers in laundries use multispeed motors to cover the range from pillow cases to blankets.

Geared alternating-current elevators for both passengers and freight use two-speed motors so arranged that the low speed is used in making the landings. The top speed is usually 900 r.p.m. and the low speed may be 450, 300, 225 or 150 r.p.m. on a 60-cycle supply. Two separate windings are required, though only two speeds are used.

Rotary car dumpers and tilting box-car unloaders have heavy balanced weights of varying amounts. Two-speed motors handle these huge machines splendidly. Limit switches actuate the pole changing control so that the critical movements such as lining up with rails are executed at slow speed.

Skip hoists afford another example of high-speed operation with slow-speed finish, obtained with two-speed motors. The skip must be gently and accurately landed at the bottom of the slope for loading and it must go into the dumping horns at the top without shock. Again limit switches make these operations practically automatic.

One of the most interesting applications of multispeed motors is in the operation of the doors on the Goodyear Zeppelin hangar at Akron, Ohio. The two doors at each end of the hangar are of orange peel shape, each pair forming a quarter of a sphere. Each door, weighing 450 t., swings about a pin at the top while the bottom, 200 ft. below, rests on trucks on a circular standard gage railroad track. Two-speed motors operate through huge gears to a rack rail to move the doors. The motors are of the wound-rotor induction type rated 200/100 hp. at 600/300 r.p.m. When a button is pressed, magnetic control brings the motor slowly up to the full speed of 600 r.p.m. through the deliberate action of definite-time, flywheel type relays. When nearing the end of its travel, either opening or closing, limit switches first insert resistance in the secondary circuit, then change the motor to the 300-r.p.m. pole arrangement with the resistance still in. Near the end of travel, a third limit switch cuts the motor off the line. By this time, the door is moving very slowly and a delayed and graduated action brake comes into play to stop it with a minimum of shock and vibration.

Metal rolling makes use of many multispeed motors in major operations. Such motors are usually of the constant horsepower type. The choice of speeds is utilized for various classes of work on the same mill or for making the first passes at low speed and the finish passes at high speeds. A list at hand shows such ratings as: 1800/1800 hp., 250/125 r.p.m. on a 22-in. merchant mill; 6500/4500 hp. at 107/53 r.p.m. on a 60-in. 3-high universal plate mill;

500/500 hp. at 750/375 r.p.m. on a copper sheet mill.

Nearly always these large motors are of the wound-rotor type. A 250-hp., 12/16/24/32-pole squirrel cage motor was recently applied to a piercing mill. The available speeds are 600/450/300/225 r.p.m.

On saw carriages the log set-works use multispeed motors to get slow speed delivery of the log to the new position for the next cut and high speed recovery in reverse. These reversing cycles take place as rapidly as fifteen times per minute. The control is arranged so that the reversing contactors do the pole changing, hence the motor always runs in one direction at low speed and in the other direction at high speed. This principle might often be used to speed up reversing operations where single-speed motors are now being used.

Centrifugal dryers may be driven in large groups on a two-frequency circuit but for an installation of a small number of dryers or extractors or where fleet control is not feasible, multispeed motors are used. The low speed throws off the major liquid content and, as the weight is reduced, the unit goes to high speed for finishing. For delicate material, it is necessary to start at low speed to avoid damage to the stock. After the major weight is disposed of, the "basket" can be operated at a high speed without danger to the contents. A typical motor for this service gives speeds of 300 and 1800 r.p.m.

The largest motors ever built, so far as the writer knows, are, curiously enough, two-speed motors. They are the 22,500-hp. propulsion motors in the air-plane carriers Saratoga and Lexington of the U. S. Navy. These are of 22/44 pole design, operating on a nominal frequency of 60 cycles, the turbine governors adjusting the frequency to give any intermediate speeds desired. The propeller loads fall off nearly as the cube of the speed, hence, at low speeds, several turbine-generators can be stopped. Some of our battleships are equipped with 24/36 pole 8000-hp. motors operating on a nominal frequency of 36 cycles.

Municipal pumping plants use multispeed motors to advantage in disposing of storm water or sewage against a variable head caused by low and high water conditions at point of disposal. These variations may be caused

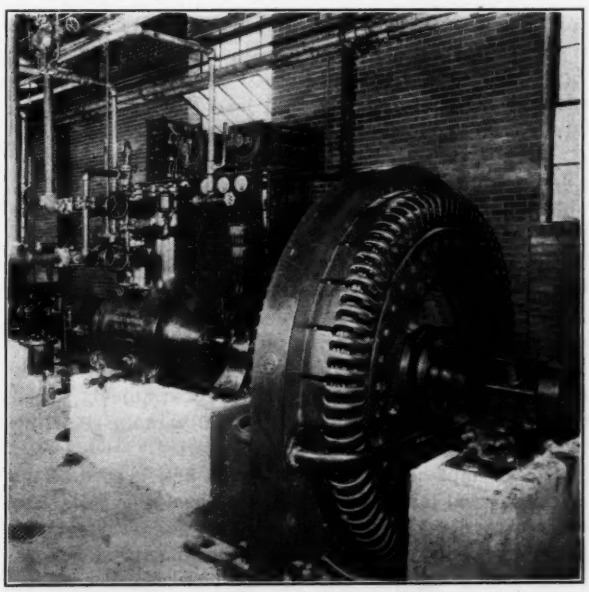


FIG. 5. TWO-SPEED SYNCHRONOUS MOTOR DRIVING AMMONIA COMPRESSORS

by floods or tides. Similar applications are found in chemical plants, pulp mills and other places where the head pumped against or the quantity to be delivered changes.

The outputs of fans, blowers and centrifugal pumps do not vary directly with speeds, hence in selecting multispeed motors for this class of service, care must be taken to choose speeds that will give the desired outputs. Mine fans sometimes have a day and night schedule of outputs which are obtained by multispeed motor drives. In a typical case, one-half output is obtained at 64 per cent speed and one-fourth output at 50 per cent speed.

Two-Speed Synchronous Motors

Two-speed synchronous motors are essentially the same as the conventional single-speed units with the addition of means for regrouping the stator and rotor poles to attain the effects of half the normal number. For the best design, the larger motors require a special form of pole at the air gap, because the air gap is not uniform over the whole pole face and because the field winding is concentrated. The smaller synchronous motors are adapted for a practical two-speed design without resorting to special poles.

Applications of these motors include reciprocating pumps, motor generators for two-frequency a.c. output or two-voltage d.c. output, mine-ventilating fans for reduced air supply during nights and holidays and refrigeration compressors for reduced winter effect. The same type of construction yields a two-frequency generator at one speed.

There is nothing special or complicated about the two-speed motor; it requires no special attention and its cost is only slightly higher than that of a normal motor of the low-speed rating. Of course, special control equipment is required.

Control

Multispeed induction motors are controlled by the usual methods for normal motors, with the addition of a pole changing switch which is operated only when the motor is disconnected from the line. A slow-speed sliding contact device such as a pole-changing switch is not adapted for rupturing the full load current of motors larger than about 8 hp.

Drum type switches are used for pole changing and below 8 hp. the same switch may be the starting device, unless otherwise prohibited. With magnetic control, the pole changing function is carried out by means of contactors but even then the changes take place when the motor is disconnected from the line. One type of drum switch for use with magnetic control has an arrangement of segments for cutting off power while the handle is being moved to a new speed position, restoring power after the change is completed. If executed quickly, speed changes may be made with this switch without resorting to the compensator after the initial start.

No attempt has been made in this article to describe all industrial applications of multispeed motors but rather a variety has been covered to stimulate interest in this inexpensive substitute for adjustable speed motors. With speed-changing gear boxes such as are used on machine tools, with secondary resistance on wound rotor motors or with adjustable frequency, a wide speed coverage may be obtained with these motors. For many purposes, the fixed speeds of the squirrel cage motors are perfectly satisfactory. On the other hand, there must be many cases where single speed motors are doing work that could be done better by the multispeed type with but little more first cost.

Commutator Maintenance*

SINCE THE EARLY days of the electrical industry, when Sunday was spent in removing the armature and turning down the commutator, progress has been great. Commutation is better, routine care is better, various grades of carbon brushes to fit the needs of current capacity, hardness of mica and voltage of commutation are available. Also tools for truing up commutators have been improved so that there is seldom need to remove an armature from its bearings for any operation needed on the commutator.

In general, difficulties in operation may be classified under the headings, sparking, blackening, flats, brush pitting, overheating, picking up of copper by brushes, brush chattering. Often two or more of these will appear but one is usually due to the other and, if the primary cause of trouble is removed, all difficulty will disappear. For instance, sparking will usually be present, to greater or less degree, whenever there is any trouble. Fine, blue sparks between brush face and commutator may be of no consequence but, when a heavy yellowish sparking appears, get after it.

Sparking

If brushes have shifted from the neutral axis, or if the neutral axis has shifted, due to changes of operation, sparks will appear. These can be lessened and should disappear entirely by moving the brushes to neutral, unless some other cause is producing sparking. If shifting the brushes does not effect a cure, set the brushes at the point of least sparking and hunt the other trouble.

Too little pressure of brushes on the commutator may give excess contact resistance. Try increasing the pressure but with caution, as excess pressure will cause too much friction and heating.

High mica may cause jumping of the brushes. This can usually be detected by holding the finger nail or a light splinter of wood nearly radial against the commutator surface as it revolves. If not bad, the mica can be cut down with a dressing stone and more abrasive brushes will keep the mica in place thereafter. If a mica is up a good deal, it is better to resurface the commutator, then undercut the mica and use non-abrasive brushes.

When mica is undercut, the filling of slots with oil and dirt may make trouble. The slots should, of course, be cleaned, dirt prevented from getting into them and, if oil is coming from bearings, take up the matter with the manufacturer of the machine. If oil comes from the brushes, consult the brush manufacturer.

Poor seating of brushes may be due to their sticking in the brush holders, brush holders loose on studs, studs bent or brush ends not shaped to the commutator. Obviously tight brushes should be freed, loose brush holders tightened on the studs and bent studs straightened.

*From data supplied by Ideal Commutator Dresser Co.

Brush ends can be shaped by use of a brush seater or by using a resurfacer in front of each set of brushes, letting some grit pass under the brushes.

Incorrect spacing of brushes can be detected by counting the bars between brushes or by placing a strip of paper around under the brushes, marking the points where the toes of brushes touch the paper and checking the distances between marks for equality. If unequal, studs or brush holders should be adjusted until equal spacing is secured, making sure that the spacing is correct along the full length of the commutator, where multiple brushes are used.

Brushes too thick may span bars beyond the neutral axis and should be trimmed down at the bearing face or, if holders of clamp type are used, thinner brushes may be used.

For high-voltage machines, brushes of too low resistance may allow local currents to be set up at the instant of commutation. If this condition is suspected, better take it up with the brush maker.

Open circuit, total or partial, either in an armature coil or a commutator connection, will cause sparking at the bar which is connected to the open circuit. The remedy is obvious.

Unbalanced magnetic circuits, due to a short in a field coil, opposing field coils or unequal air gaps will cause sparking, generally greatest at one set of brushes. Test the coils for equality of resistance, examine connections of coils and test air gaps with thin wedge feelers at both ends of the armature core. A shortened coil calls for rewinding or repair of insulation; wrong connection should be righted; unequal air gap, if due to worn bearings, can be corrected by adjustment or new bearings. If poles are of unequal length, the manufacturer should be called on to make them right.

For machines with interpoles, the interpoles may be out of adjustment or incorrectly shunted. Here the manufacturer should apply the remedy.

Unstable foundations, jerking belts or pounding engines may cause vibration which will result in sparking and should be overcome, not only to stop the sparking but also the wear on other parts of the machine.

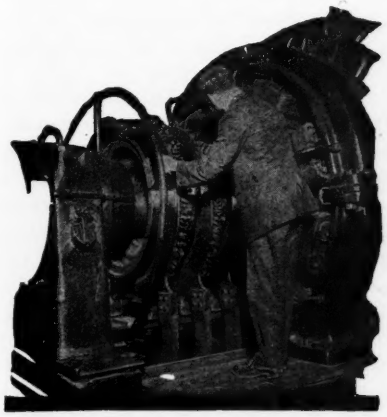


FIG. 1. PRECISION GRINDER IN OPERATION

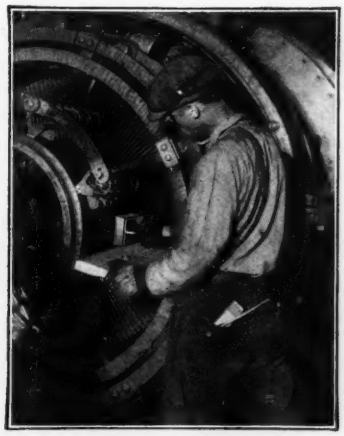


FIG. 2. RESURFACING A MEDIUM SIZE COMMUTATOR

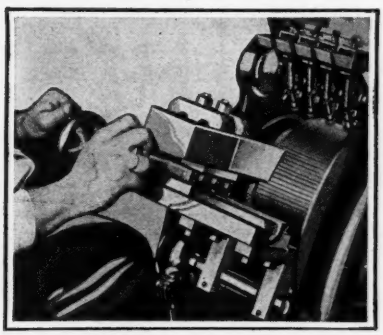


FIG. 3. HAND RESURFACING ON A LARGE COMMUTATOR

Blackening

This often results from sparking, due usually to too much lubricant in the brushes, leakage of oil from bearings or to surges of current which overtax carrying capacity of the brush contact. Cleaning off the oil, using brushes of more abrasive quality and adding more brushes in multiple are the remedies. Oil leaks from the bearings are up to the manufacturer but an oil slinger ring with shield or a wiper at the inside end of the bearing may serve to keep the oil away from the commutator.

Flats

High or low bars may come from a loosening of the clamping rings, from uneven hardness of mica or bars or from mechanical unbalances of the armature. They should be cured at once, as they not only get worse but are destructive of brushes.

Clamping rings should be tightened, the commutator carefully resurfaced and the armature brought into balance. In resurfacing, the tool or abrasive should be held in a fixed rest, Fig. 1, and fed mechanically, the grinding surface being at least three times the width of the flat spot. If hard mica is suspected, it is best to undercut the mica and use non-abrasive brushes.

Brushes Burned and Copper Flecked

Overheating from insufficient current capacity at the contact surface of all or part of the brushes is the usual cause of burning. This may be from too high resistance of brushes, insufficient brush pressure or unequal pressure on different brushes, jumping of brushes, or too low brush resistance, causing local shorting at commutation as already mentioned.

Equality of pressure can be tested with a spring balance. Other causes had best be referred to the brush manufacturer for advice.

Picking up of copper by brushes is due to heavy sparking or heating which softens the bars, or to failure to keep the commutator clean. Causes of heavy sparking such as brushes off neutral, bad spacing, thick brushes, unequal air gaps, low contact resistance, or unbalanced armature winding will cause heating of the bars so that

brushes will cut out specks of copper. Brushes too hard may cut the bars even at normal heating.

Unless copper and abrasive dust be carefully cleaned off after turning or grinding, the brushes, especially if soft and containing considerable lubricant, will pick up the copper and sand and will cut the bars. Prevention is to clean up after turning or grinding.

Brush contact surfaces may be cleaned of copper by sandpapering but will pick up more copper, unless the cause of heating is removed.

Overheating

Overload and friction are the two chief causes and have been already discussed. The overload may be at all brushes, due to insufficient area or pressure too light; it may be at part of the brushes due to unequal pressure;

FIG. 4. UNDERCUTTING MICA WITH POWER CUTTER

or it may be local shorting due to brushes being too thick or having low contact resistance.

Friction is from too great brush pressure. If sparking follows the use of less pressure, brushes should be changed, the makers' counsel being the best guide. Generally, when sparking is overcome, excessive heating will disappear.

Chattering

Chattering or jumping of brushes may come from a roughened surface, high mica, high or low bars, light brush tension with vibration of machine, looseness of brushes in holders, brushes too thin or set at the wrong angle to the commutator surface.

Truing the surface, stopping vibration, correction of brush setting and using brushes which nearly cover two bars will, in most cases, cure the trouble.

Trouble Indications

Each difficulty is usually linked to some other and may be due to one or more of several causes. In seeking the cause, one possibility at a time should be investigated until the culprit is located. The following hints may help in the search: Weak field usually shows as sparking plus poor voltage regulation on a generator or poor speed regulation on a motor. For a shunt wound machine, a short in the field will cause low generator voltage or high motor speed plus heavy sparking at brushes next the shorted coil; all field coils will be too hot. An open field circuit will give like indications of voltage, speed and sparking but the open coil and those in series with it will run cool. Open armature circuit will cause a flashing spark at one bar, the flashing following this bar around under successive sets of brushes; generator voltage and motor speed will fluctuate. Sparks due to vibration are independent of load and seem lifeless, where as those due to electrical troubles will increase with load and have a vicious snap. Opposing fields will show somewhat the same symptoms as a shorted field coil but without heating of the field windings.

Truing and Resurfacing

For serious out of round, the commutator must be turned or ground, the tool being held rigidly, most conveniently by a fixture mounted on a brush-holder stud. For turning down, the tool should be of correct form and set at the proper angle to give the best cutting for copper and mica and mounted so that it can be fed against the commutator mechanically to take off just the amount needed, then moved evenly along the length of the commutator. After the turning, or in case but a small amount of truing is needed, an abrasive grinder may be used, mounted in the same holder and fed in the same way. A generator may be driven by the prime mover or a multipolar motor may be run under its own power by removing one set of brushes to make a place for the tool holder and lifting the opposite set off the commutator.

If irregularity of surface is only slight, the resurfacing may easily be done by a hand tool held against the commutator and, for large machines, bearing on a board, Fig. 2, held against a brush holder stud or on the brush holder stud direct, Fig. 3. Use of a hand resurfacer as soon as any surface irregularity appears is the stitch in time which saves work later.

For abrasive, the requirements are that it cut fast, cut freely and does not clog with copper or mica yet lasts well. Manufactured abrasive has proved better adapted to the work than natural stones and is commonly used. It is to be had in three grades: coarse for fast cutting where considerable material is to be removed; medium for high mica and small ridges; finish for bringing the surface to a velvet finish after use of either of the other grades. Some engineers like also to use a silica base polish after the finish, this polish having no cutting property.

When using hand resurfacers, it is better to have the grinding surface as wide as is consistent with the diameter of the commutator and spacing between brushes and for grinding out slight flats the surface should be at least three times the width of the flat. The length should be about ¾ that of the commutator bars.

For undercutting mica and cleaning out slots, special files and scrapers are available, or where a large amount of work is to be done, a power cutter with saw, Fig. 4, may be used. For an emergency job, home-made cutters can be constructed by mounting hack-saw blades and files in wood handles but the regular tools are better fitted for the work and more convenient.

Truing of the commutator will not correct trouble due to grounds, shorts, open circuits or vibration but keeping it always in perfect condition will minimize destructive action until the real trouble maker can be corrected and will avoid serious effects which will follow if minor commutator defects are neglected.

Belt Condition for Multiple V Drives

By R. E. S. Geare*

FREQUENTLY, in a multiple V-drive, one or more belts will be noted to sag more than adjacent belts, the conclusion being reached that those belts which show the greatest sag are stretching badly. While this may be true in rare cases, usually the sagging belts are a small fraction of an inch longer than the other belts and were so at the time of installation, or the V-grooves

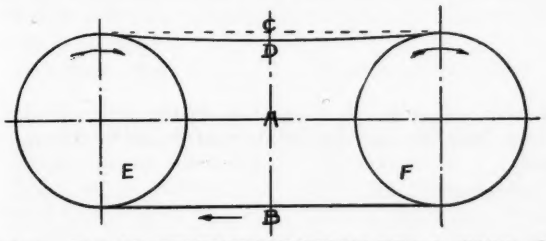


FIG. 1. SAG CD INCREASES RAPIDLY FOR A SMALL INCREASE IN BELT LENGTH

in the sheaves are incorrectly cut, or the lodging of dirt on the sides of the grooves has produced unevenness in the belts.

Few engineers realize the large sag effect that will result from the addition of a fraction of an inch to the length of a belt, as a consideration of this point will prove.

Assume a driving pulley E and a driven sheave F with a number of V-belts. It is desirable but not of great importance from the standpoint of efficiency to have all belts of exactly the same length. It is true, as a general thing, that with an increasing length of belt, and resultant sag CD, arc of contact will be greater on each sheave, hence a higher degree of power transmission. Considering the fact, however, that V-drives are figured for 180 deg. angle of contact as a rule, with an efficiency of transmission as high as 98 per cent there can be on a standard drive, no great advantage in increasing the sag purposely. This sag CD may appear to be great, yet the factor which creates it small.

For instance, the table shows a number of different distances between centers and the sag CD for difference in length of belts of ½ in. and 1 in. The driving side is assumed without sag.

Center Distance Between Sheaves, in.	½ in. DL Approx. Sag	1 in. DL Approx. Sag
10 in.	1.6 in.	2.2 in.
20 in.	2.2 in.	3.2 in.
50 in.	3.5 in.	4.9 in.
100 in.	5.0 in.	7.0 in.

DL designates difference in length between a belt which is taut between two sheaves and one which is increased by the dimension shown. It becomes apparent that for a given difference in length of belts, the actual distance of sag increases in proportion to the distance between centers.

In construction of a belt with all power transmitting cords at a neutral axis, exact lengths are obtained because of the use of moulds of similar length. Furthermore, the additional use of properly vulcanized rubber surrounding the cords, together with breaker strips, effectually stops any tendency to stretch.

Belt stretch, however, is not the cause in many cases for unequal sags in belts. The greatest trouble is usually found in the sheave itself. Figure 2 shows the action of a V belt in its groove. At A the belt is entering the groove, at B it is seating and at C the sides are in full contact with the sides of the groove. Load is picked up gradually as the belt seats itself which naturally exerts a shock absorbing effect, independent of the elasticity of the belt itself. This is the ideal condition. If all grooves are cut correctly and are polished, this action will take place simultaneously in each belt of the drive.

Assume, however, that the angle of one or both sides of groove is incorrect, that rust or foreign material has deposited on one or both sides of the groove, or that sides of the groove are roughly machined. Any one of those items will make the belt ride high in the groove, so that the other belts will have the appearance of sagging. Furthermore, one high spot on the side of the groove would cause an up and down slap of its belt. Under such conditions, the sides of the belt would not engage properly against the sides of the groove. Loss of power transmitted by that belt would result.

It is of great importance to use properly machined V-sheaves and a belt that actually stretches badly under

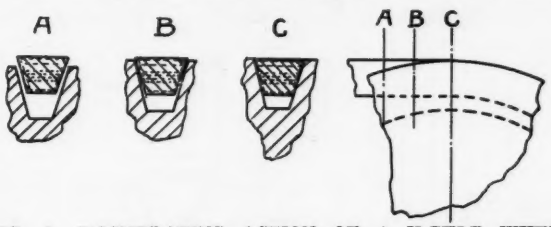


FIG. 2. ILLUSTRATING ACTION OF A V-BELT WHEN SEATING IN THE GROOVE

load conditions is undesirable. Yet it is reassuring to know that a V-belt drive, with accurate grooves, will give efficient power transmission, even though belts are of unequal length. The sheaves, however, must be accurate.

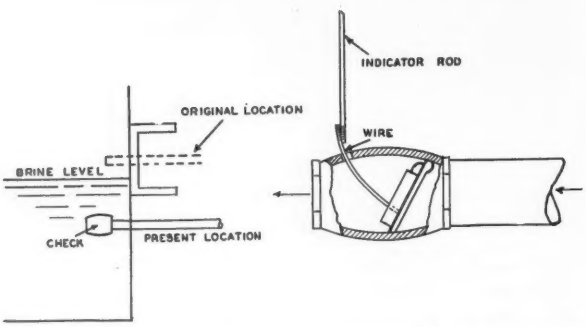
Dedication of the new Minnesota Valley Steam Plant of Northern States Power Co. at Granite Falls, Minn., was held on October 13 when 174 officials of the company and visitors made a tour of inspection of the project and enjoyed a dinner in the dining hall of the plant. The visitors were guests of the company and of C. D. Hunt, manager of the division. W. T. Walker, superintendent of special construction for the company, was toastmaster at the banquet. At the time of the dedication, construction of the new plant was virtually completed. One of the two 10,000-kw. generators was installed and had been in operation for several weeks, while the second generator was ready to start within a few days.

An adequate supply of spares should be as much a part of the order as the machine itself. Even though spare capacity is available, a breakdown reduces the reserve or factor of safety, and every hour that a broken machine is out of service is a reflection on the engineer in charge. A few well chosen spares or repair parts cost little and are good insurance.

*M. E., L. H. Gilmer Co., Philadelphia, Pa.

Old Check Valve Serves as Flow Indicator

FOLLOWING SOME recent remodeling, we were bothered by considerable corrosion of our evaporator coils. There had always been some pitting, though not of a serious nature, but the increased corrosive action worried us. After considerable investigation which came to naught, a visitor suggested that the trouble was due to oxygen in the air which was carried in by the brine return. Inasmuch as the corrosion seemed to be confined to the more or less immediate vicinity of the return



CHECK VALVE WITH BAMBOO ROD INDICATE WHEN RETURN FLOW TAKES PLACE THROUGH PIPE

pipe, this explanation sounded reasonable so we took steps to correct the difficulty.

Originally the return was very close to, but above, the surface whereas the new return was several inches lower. Because of a beam which had been put in to support some new tanks, it was impossible to return the line to its old location, though even had it been possible to do so, it was not thought wise, as in that location there had been some pitting and as long as a change had to be made there was no reason why the trouble should not be entirely eliminated.

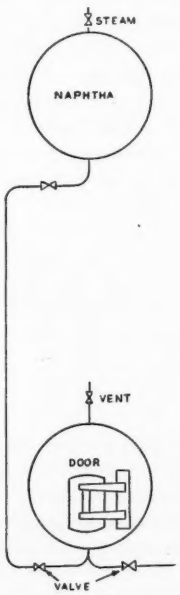
Therefore, the return was brought in below the brine level. This caused the engineer a great deal of worry because he could not watch the return flow of brine. He corrected this by taking an old check valve and screwing it on to the end of the pipe. There was a plug in the body of the valve which he removed and, by means of a short piece of wire, he fastened a light strip of bamboo in an upright position against a black piece of board. This gave him a reliable indicator as the pointer rose when the flow through the pipe raised the check from that portion of the seat which he left in the body.

Springfield, Ill. F. PAUL.

Pumping Naphtha Without Mechanical Movement

FORTY YEARS AGO, the ordinary start and stop engineer did not put so much time into mathematics and midnight oil as he does today; the times did not demand it, yet bright ideas cropped out which were worth chronicling. A man by the name of Savin, who operated a grease reclaiming plant in a New England city at that time, brought forth a scheme for pumping naphtha without mechanical movement.

In the process of extracting grease from curried leather, naphtha in large quantities was used. The leather clippings, salvages from boot and show shop waste, were placed in crates, which in turn were packed in a tank, a door being provided for the purpose at one end of the tank as illustrated. The crates were flooded



CONDENSATION OF STEAM PRODUCES PARTIAL VACUUM PERMITTING AIR PRESSURE TO FORCE NAPHTHA INTO TANK

with naphtha admitted from a tank on the floor above and the process started.

After due time, the grease became free from the leather and was drawn from the tank, leaving the naphtha to be returned to the upper tank by atmospheric pressure.

Steam at low pressure was admitted to the upper tank and the air expelled. As the steam condensed, a partial vacuum was formed. Partial vacuum in the upper tank and atmospheric pressure in the lower tank forced the naphtha into the tank.

The leather, free from grease, made good fuel with which to make the steam that pumped the naphtha. Of course, it was just as essential to avoid air leaks 40 yr. ago as it is today.

Lawrence, Mass. CHARLES J. WILDER.

Handy Brick Cleaning Kink

CLEANING the old and hardened mortar off a bunch of brick is an exceedingly tedious job, tiresome and painful to the hand and wrist holding the brick. Take

POST DRIVEN AT AN ANGLE IN GROUND AND STONE BASE FORM HANDY BRICK CLEANING DEVICE

an old piece of 2 by 4-in., three or four feet long and drive it into the ground at a slight angle, leaving only some six or seven inches above. Pound a small block firmly into the ground near the foot of the upright. Lay the end of the old brick on this, leaning the brick against the longer piece as shown. The brick is easily held with the fingers while chipping off the mortar. A much cleaner and better job can be done with absolutely no danger of cracking or breaking a soft brick which often happens when trying to hold in the hand. Next brick salvaging job you have, try this. You will get it done quicker and with much less work.

Missouri Valley, Iowa. FRANK BENTLEY.

Cleaning Commutators

I WAS INTERESTED in H. J. Achée's letter in the September 15 issue regarding the cleaning of commutators and brushgear.

For cleaning dirty commutators, I have found nothing better than ordinary liquid metal polish. This will be found to remove any dirt and grease but will not scratch the copper. Metal polish is also excellent for cleaning any electrical contacts, as it not only removes the dirt and grease but also the film of oxide which forms quickly on the surfaces. For cleaning the brush rigging, if cleaning is performed weekly so that any grease which may have collected has time to harden, a dry cloth should remove all the dirt.

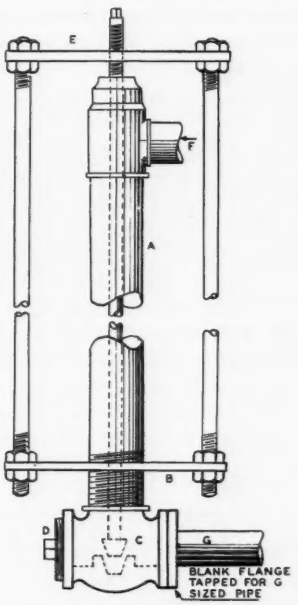
When cleaning brushgear, there is always difficulty with the lower sets of the brushes due to their inaccessible position. To overcome this difficulty, I have found the placing of a mirror on the floor beneath the brush rigging to reflect the light from a portable lamp on to the brush rigging to be effective. It will be found that using a mirror in this way will be of great assistance when inspecting parts which are inaccessible.

Billericay, Essex, England. W. E. WARNER.

Expansion Operates Home-made Steam Trap

ALTHOUGH made of fittings that are available in any power plant, the expansion trap illustrated works successfully.

As shown, the condensation chamber A, which should be at least 3 ft. long, is made larger in diameter than



TWO-WAY EXPANSION TRAP FOR STEAM LINES, MADE OF PIPE FITTINGS

the waste discharge pipe G. Condensation chamber, A, serves as a receiving chamber into which the water condensed from the steam collects and, as it cools, the inner rod contracts, thus opening the valve C and permitting the water to flow out through pipe G. After the water has been discharged, steam enters pipe A and the rod and pipe expand, closing the valve.

With this design, the expansion of the pipe is upward, since it is held rigidly at the bottom and can slide along the rod at the top, while the expansion of the rod is downward since it is held rigidly at the top at E.

In constructing this trap, the bonnet and packing were removed from the globe valve, C, and the long rod

shown was attached to the valve stem. Pipe, A, was screwed into the valve at its lower end after screwing through the lower plate B. A tee, into which the inlet pipe, F, is screwed was attached to the upper end of pipe, A, and into the upper end of this tee a reducing fitting, which was drilled to permit the inner rod to pass through it, was attached.

Discharge pipe, G, was screwed into a companion blank flange which was tapped for this purpose and plug, D, was screwed into the other end of the valve so as to permit removal of sediment without disturbing the setting of the device. The upper part of the long rod was threaded and screwed through the upper plate E. Its upper end was filed square so that it could be adjusted by a wrench.

Plates B and E are held rigidly in relative position by means of two rods supplies with companion nuts. This trap acts promptly, is regulated automatically and discharges the condensed water without loss of steam.

Toronto, Canada. JAMES E. NOBLE.

Removal of Shunt from Interpole Winding Improves Operation

MANY ATTEMPTS to get good operation of an old railway motor with an interpole shunt, were unsuccessful. Perfect operation was finally obtained by removing two turns from each interpole coil and operating without any shunt around the interpoles.

This machine was one of the earlier types on which interpoles were often wound to give the magnetic strength of the interpole too great and this was reduced to the correct value by placing shunts across the interpole coils. That serves well enough for ordinary loads but, for fluctuating loads, such as street railways or steel-mill duty, the results are unsatisfactory. The reason is that the shunts are practically non-inductive, while the interpole windings are inductive; hence, when a sudden change in load occurs, most of the added current passes through the shunt and the current in the interpole coil is insufficient to maintain the interpole strength at the correct value for the increased armature current. Consequently sparking occurs at the brushes.

Hobart, Ind. HARRY J. ACHEE.

Diesel Crankshaft Alinement

REFERRING to the article on Diesel Engine Upkeep in the September 15 issue, I agree with the method of checking crankshaft alinement as illustrated in Figs. 7 and 8.

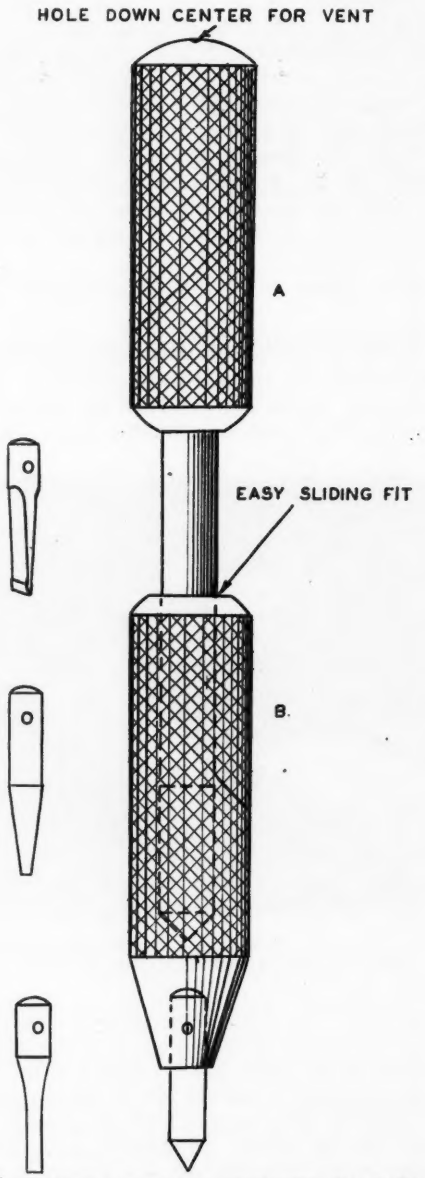
A certain amount of tolerance is permissible, however. With 6-in. shafts, this difference should not exceed 0.002 in.; for 8-in. shafts, 0.003 in. and for 11-in. shafts, 0.004 in. may be allowed.

Billericay, Essex, England. W. E. WARNER.

Self Contained Hammer Punch

THE SHOP mechanic who is handy at the lathe can make the useful shop tool shown in the sketch in a very little time. It consists of two main sections, A and B, which are made from a piece of old model T Ford axle turned and drilled in the lathe and knurled for a grip. The upper piece is an easy sliding fit into the lower piece B and the lower end of B is drilled to take various types of drifts, punches and chisels. These are made from drill-rod, hardened and tempered and a notch ground in them to hold them in the punch as indicated.

In use, the tool is held with one hand on B while



SLIDING WEIGHT ACTUATES PUNCHES, VARIOUS TYPES OF WHICH MAY BE INSERTED IN TOOL HOLDER AS DESIRED

the other end A is rapidly slid up and down, the weight striking an even and direct blow. I find the tool handy about the shop.

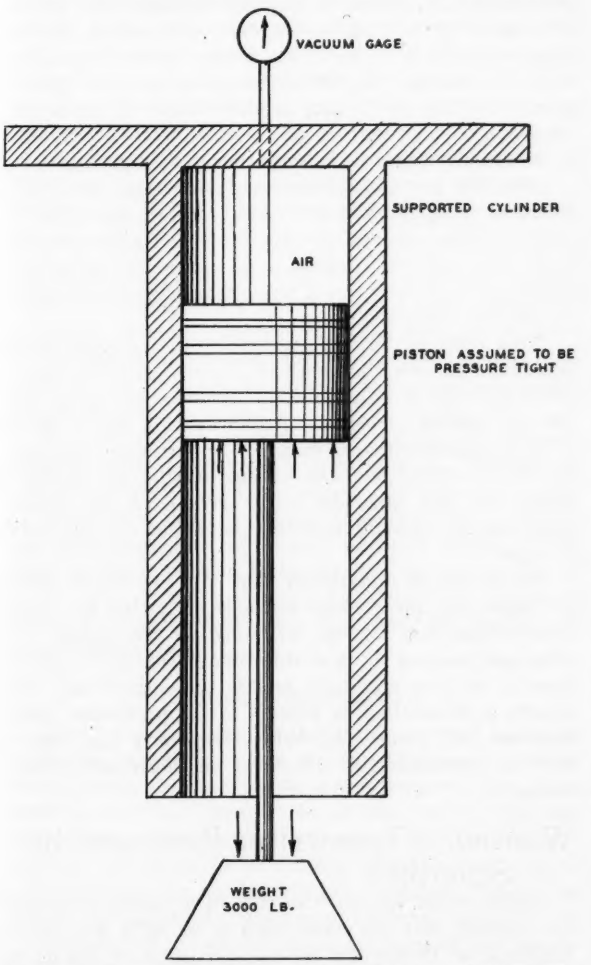
Pennacook, N. H. CHAS. H. WILLEY.

RECORDING INSTRUMENTS are one of the biggest helps a chief engineer has in the operation and supervision of his plant. Not only do they give him permanent records from which to calculate the performance of the plant, but they keep a silent but indisputable record of the operators' actions during the many hours the chief must be away from the plant.

Questions and Answers

Effect of Unbalanced Air Pressure

EFFECT OF an absolute and of a partial vacuum puzzles me. Referring to the sketch which I am enclosing, will you please explain the conditions of vacuum or



WEIGHT SUSTAINED BY ATMOSPHERIC PRESSURE BELOW THE PISTON

pressure which would be registered on the gage shown for a condition in which the base of the cylinder is at floor level and when the cylinder is suspended at some elevation? What causes the weight to be suspended in either case?

F. A. S.

A. Assuming that the piston is held in a balanced position by the pressure conditions, that it is packed so that there is no leakage and that it is frictionless, the absolute total pressure above the piston would be equal to the absolute total pressure of the atmosphere on the bottom side of the piston minus the weight, including the weight of the piston and rod, which is hung from the piston.

Atmospheric pressure at any point is measured by a barometer and is greater at low than at high levels. Therefore the absolute pressure above the piston, other things being equal, must be less, that is a higher vacuum, the lighter the atmospheric pressure, which would be found at the higher altitudes above sea level.

Obviously there would be no appreciable difference in atmospheric pressure between sea level and that at few feet elevation. The atmospheric pressure at sea level at 58 deg. F. is 30 in. of mercury while that at an altitude of 5403 ft., over a mile in height, is 24.41 in. of mercury. Since 1 in. of mercury represents a pressure of 0.49 lb., it will be seen that the atmospheric pressure difference between these two altitudes is only about 2.74 lb.

Let W = suspended weight including rod and piston = 3000 lb.
A = area of piston in sq. in.
p = atmospheric pressure at altitude of test, in lb. per sq. in., abs. Assumed to be 14.7
V = absolute pressure in lb. per sq. in. above piston.
We have, therefore, $pA - W = VA$.

Since the vacuum above the piston cannot possibly be more than perfect, which would mean zero pressure, the limit of weight that could be sustained in equilibrium would be

$W = p\,A$.

If we assume perfect vacuum, the diameter of cylinder necessary to support the weight 3000 lb. would be determined as follows:

$3000 \div 14.7 = 204$ which is the area necessary to support the weight. This corresponds to a diameter of piston equal to $16\frac{1}{8}$ in.

For any pressure in the cylinder between zero and atmospheric pressure the weight that could be held up would be:

$W = p\,A - VA$.

Determination of Impurities in Fuel Oil

HOW CAN THE amount of water and dirt contained in fuel oil be determined? W. D.

A. Take a sample of the fuel oil from a well mixed quantity and place it in a test tube to which should be added an equal quantity of gasoline. After this has been thoroughly mixed and allowed to stand in a warm place for 24 hr., the dirt and water will have settled to the bottom and their proportional amounts may then be determined.

Editorial Comment

Now Is the Time

In the power plant, as in practically every other department of an industrial plant, it is practically impossible to keep up with the power and steam demands during periods of flush production. Of course, the demand is met in some manner often at the expense of costly deterioration of equipment, which cannot be stopped for repair when signs of distress are noticed.

Expense of standby equipment is often dispensed with and the only margin of safety lies in first class maintenance, keeping the machine or boiler in good condition. Such operation is hazardous to the output of the factory, besides necessitating frequent expensive overtime work at night or on Sunday.

Now is the time to make a survey of your plant and put it in the best possible condition to meet the demands which will be put upon it later. If standby equipment can be purchased and installed, so much the better. If not, equipment here and there should be replaced or new equipment added. It may even be possible to lay out an entire new plant and make changes now which will fit in later with new developments.

For instance, a paper mill now using low-pressure boilers was recently faced with a shortage of steam capacity. A new high-pressure power plant is planned in the not too far distant future and, if installed, a new low-pressure boiler would have had a useful life of but three or four years. Instead a steam accumulator was installed as part of the future high-pressure plant and saved the cost of a new boiler.

Practically every plant offers possibilities of this kind. Make plans for rebuilding your power plant now while you have the time. Put as much of the plan as possible into effect immediately and the balance as soon as business conditions enable you to get the money.

Can We Eliminate the Misfits?

More than ever before, society must attend to the problem of supplying guidance to its young people in the extremely complicated business of finding what work they are best fitted for by temperament and talents and how they can prepare themselves for that work—what they should do, in short, to develop all the talents they possess in proportion to the vigor of those talents, with the object of producing well-rounded individuals, able to fit themselves into a complex civilization.

That this is a real problem can be easily proved. The rise of our present industrial system, based on the factory system and the quantity production system, has created new problems for the individual who must adjust himself to it. But we have not space to discuss the mass of evidence that points to a greater degree of maladjustment of the individual to his environment than the world has seen before.

To add to the confusion, few methods have been available for determining an individual's natural aptitudes. Most of the psychological and mental tests so far available were developed primarily for other purposes.

Recently, however, Johnson O'Connor has formulated methods of testing native abilities that give promise of some unusually valuable results. He has developed various work-samples, the solution of which indicates aptitudes for engineering, executive, research and many other activities. That is, the tests indicate that the individual's latent talents, the ones with which he was born, can be best utilized in a certain type of work and that his chances of success as an individual will be greater in that work than in other lines. It cannot be predicted that he will succeed in that work but at least it can be shown that he belongs in a certain group.

Already a testing laboratory has been established where anyone, for a most reasonable fee, can take the tests. If they can aid in classifying men and especially boys into general groups that have characteristics needed for certain types of work, what a world of misfits we may be able to eliminate!

This work is of particular value to the engineering profession at this time because, in a civilization whose every activity is influenced by engineering, many people are coming to believe that, even if a boy is going to be a department store manager or a surgeon or a bond broker, a certain amount of engineering education is about the best thing he could have as a foundation. Some account should certainly be taken of that point of view.

It should be understood that Mr. O'Connor makes no claim that the present methods of testing are infallible or that they are the last word on the subject. Of principal interest to us at this time is that they seem to show a way to eliminate misfits in engineering, with benefit to themselves as well as to the profession, while they are still young and before they have had time to feel the extremely bad effects of an improperly chosen career.

Wanted, a Typewriter Keyboard by Scientists

Many centuries ago wise men in monasteries devised an alphabet that has come down to us, with some modifications, as twenty-six letters. With those letters we are able to represent every human sound used in conversation.

Now comes the scientist with his desire to cut corners, abbreviate thinking, distinctify formulas and lo, what an upset apple cart we now have. He not only wants the English alphabet in caps, lower case and italics; he must also have the ten numerals in regular size and all these characters must be provided in small sizes to be used as superior or inferior letters or figures. Mathematical signs are, of course, essential but he demands a full complement of Greek letters, caps and lower case; the next step may be to Chinese characters.

Power Distribution and Utilization Number

JANUARY 1, 1931 ISSUE

ECONOMY in generation of power is important but, after all, wasteful methods in distribution from switchboard to the point of application and carelessness in utilization of power in motors and lighting system can cause greater economic loss than a few per cent low efficiency of generating plant.

A few hundred pounds of coal wasted at the mine involves a comparatively small expense. When the same amount has been transported to a plant, burned, the heat used for making steam, then electricity and, finally, energy transmitted to the customer the value of the energy is greatly enhanced and, if wasted, the expense involved is multiplied many times. For this reason, Power Plant Engineering will devote its January 1, 1931 issue to economy in distribution and utilization of power in the forms of heat, mechanical energy and electric current.

DISTRIBUTION

In every instance, energy must be distributed from the boiler, prime mover or electric generator to the point of application and distribution of steam is the first step, whether heat of the steam be used direct or transformed into other forms of energy.

This involves an efficient piping system, of adequate capacity, good design and construction and with proper valves to control the steam flow so that none be wasted. Also radiation must be reduced, condensation removed and strains avoided to ensure effective action of the steam in the apparatus to be supplied and durability of the system. The first consideration will be of the steam piping system but water and compressed air piping will be adequately treated.

ELECTRICAL TRANSMISSION

From the generator switchboard, current must be conducted, subdivided and regulated to supply power where and as wanted with the lowest economic loss. This involves circuits of proper size so that neither line loss nor overhead charges shall be excessive; location, support and safeguarding of circuits to prevent damage to generators, driven machinery and operators; facility in regulating voltage and amount of current supplied; and a knowledge of the conditions in all parts of the system at all times. These items and the equipment involved will be some of the subjects considered.

MECHANICAL POWER SUPPLY

For secondary distribution, as in group driving, shafting, belts and gears are an important factor and here attention to proper conditions can prevent considerable waste, not only in power used but in deterioration of equipment.

Adequate strength and capacity are essential but excess increases power losses and overhead expense. Shafting properly supported and kept well lined up, belts in good condition and at proper tension, gears well fitted and adjusted and they, as well as bearings, well lubricated, make a lot of difference in the power used to operate the driven machinery.

HEAT

Energy as heat is used mostly for heating buildings and for process work either in steam or in water. Both mediums will be treated, including methods, systems and equipment for heating temperatures, pressures and amounts of heat for various kinds of process work and how to secure best utilization of the heat supplied.

Systems supplying water under high pressure for fire, lifts, presses and the like must be given careful consideration, if they are to meet demands at critical moments yet be of reasonable cost, free from interruption and from waste of water.

COMPRESSED AIR

Use of air is rapidly increasing because of the many ways in which it can conveniently replace manual labor for driving tools and hoists, for cleaning and spraying, for small motor drive and the like. Problems in its use involve the pressures, temperatures and amounts required for the work to be done and control to prevent waste.

ELECTRICITY

This may readily be converted into power, light or heat and is a most convenient medium for producing all three.

Efficient use, however, involves careful selection of motors, lamps and heating units to meet the requirements of each case; arrangement of the system and of controls so that motors, lamps and heaters are not run needlessly and planning of loading so that equipment will be used to full capacity as much of the time as possible, yet never be overloaded or inadequate.

Suitability of various types of motors for different kinds of work, amount of light needed for best effectiveness of workers, comparison of electric with other forms of heating as to cost, flexibility and quality of product are factors needing consideration. Load factor, power factor, line loss, voltage regulation, all enter into the question of economy in the use of electric power.

Evidently much can be accomplished in power saving by study of distribution and utilization systems and methods. And power so saved is high-value energy, well worth saving.

Readers of Power Plant Engineering have shown great interest in the past in this phase of their work and will value the Jan. 1, 1931 issue as a ready reference and guide in meeting problems as to the most economical methods, systems and equipment for distributing and using energy, whether heat,, mechanical or electrical and whether generated in their own plants or purchased from outside.

INFORMATION EXHIBITS AND DISPLAYS *at the* NATIONAL POWER SHOW

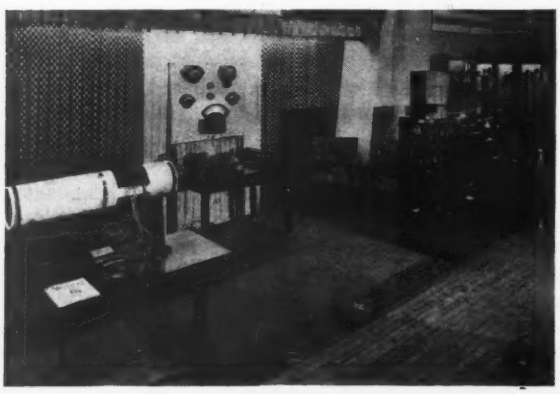
Grand Central Palace New York, Dec. 1 to 6

Floor Plans, Locations, Exhibitors and Representatives

MINIMUM production costs are in the mind of every manufacturer, be his product metalware, woodenware, textiles, leather goods, heavy machinery or electric current. While, in some cases, fuel and power may be a minor expense in production, savings in the cost of power and heat energy are worthy of careful attention. Often, too, larger use of power can be made to decrease the cost of production, hence a study of methods for applying power may open up great opportunities. Every wide-awake manufacturer and engineer is keenly interested in these two phases of power development, better economy in production and use, and wider use to save labor and increase output.

Exhibits, displays and demonstrations at the National Exposition of Power and Mechanical Engineering will exemplify the latest developments in equipment for both purposes and careful study will give plant and production engineers new ideas to bring before their managements of how to save in costs.

Some 420 booths, shown on the accompanying floor plans, will be occupied on the three floors of Grand Central Palace. Exhibitors, seeking intensively for business, are giving much attention to making their displays interesting and instructive. They will show, to a considerable extent, full-size equipment, even in heavy machinery, with experienced attendants to demonstrate and explain its action and advantages.



Furnaces and High Pressure

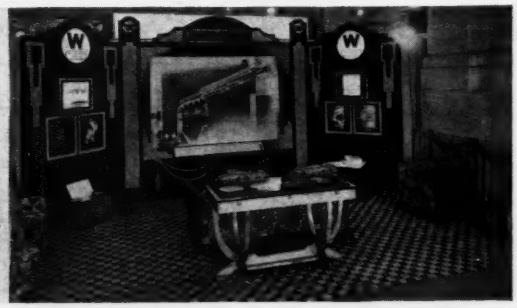
Basic in power production is the furnace and its equipment. For burning fuel either in pulverized form or on stokers, an interesting variety of exhibits will be found, giving opportunity for comparison of these two methods. Each manufacturer will be ready to explain the special features which he offers to contribute to efficiency, ease of operation and overall economy. Even for what are usually spoken of as small plants, equipment is now available to reduce labor and increase efficiency at a cost which insures good return on the investment.

Higher pressures are becoming common, resulting in special fittings, valves and instruments, of which new designs will be in evidence. The economy of increased pressure, whether to 400 lb. or to 1400 lb., is generally recognized. Engineers must look forward to dealing with such pressures in the near future and the National Power Show will give an excellent chance to become familiar with requirements and equipment for advanced practice.

Distribution of power and heat and the amounts used by each department of a factory are important in determining costs. Here the instrument manufacturers offer assistance and will show what they can do to establish complete records, which not only check the economy of the generating plant and make for better operation but show where the energy goes and tend to reduce unnecessary use of power.

Piping is usually thought of as a system of tubes having little effect on plant economy so long as it doesn't leak. With higher temperatures and pressures, questions of expansion, radiation, friction loss, tight joints are making plant operation a matter of thought and study of conditions rather than of physical activity. This demands, on the part of the engineer, familiarity with these modern methods and equipment, their construction, purpose and operation. Where better, than at a great comprehensive exhibit of power plant and mechanical engineering machinery, can such familiarity be acquired?

Following is a list of exhibitors, their displays, and representatives at the Exposition. From this one can choose the items of special interest to him but he should remember that all exhibits will have features of value



demand attention and understanding. Such understanding can be attained from the exhibits relating to piping and accessories at the Show.

Furnace Control

Time was when it was thought impossible to get a furnace too hot. Now, with high temperature preheating of air, which is becoming standard practice with many plant designers, the temperature in the furnace becomes strenuous for refractories and walls must take heat away from gases rapidly. Air-cooled blocks, water walls, water-cooled refractories are among the answers to the problem and all the latest wrinkles will be standing in line for inspection.

Brains rule the power plant now. Brawn is relegated to the rear rank, while automatic stokers, pumps and fans, controlled from a distance, do the heavy work. Gages and indicators to show what's going on; switches for remote control of motor speeds; relays to regulate fuel, air and water supply according to steam demand of which he may need knowledge at any time. All will be worth investigation.

Grand Central Palace is easily reached by elevated, subway or surface lines. It is on Lexington Ave. between 46th and 47th Sts., and will be open from noon until 11 p. m. December 1st to 6th.

Meetings of the American Society of Mechanical Engineers at 29 West 39th St. and of the American Society of Refrigerating Engineers during the same week as the Show furnish added incentives for engineers to plan a trip to New York at that time. Study of the Exhibit Directory herewith, planning of the trip to secure desired information and keeping a record of information gained and of sources of information for future reference will add greatly to the profit from the visit to the Show. It is easy to forget wanted details. A well-filled notebook is a life saver when you're trying to remember.

Here's wishing you a pleasant journey and a good time.

Directory of Exhibits

Abrasive Mach. Supply Co., Booths 520-1
Newark, N. J.

Advance Engineering Co., Booths 271-4
168 Washington St., New York, N. Y.

This company represents in the New York territory Armstrong Machine Works, Templeton Steam Trap Co., A. W. Cash Co., Smith-Monroe Co., Chicago-Wilcox Manufacturing Co., Instant Water Heater Co., Kelly Co. The exhibits in these booths will cover Armstrong Inverted Bucket Steam Traps, Templeton Boiler Feed and Pumping Traps, Cash Standard Reducing and Regulating Valves, Gast Compressed Air Separators and Aftercoolers, Wilcox Self-Sealing Gaskets, Instant Copper Tube Steam Water Heaters and Economizers, Kelly Self-Grinding Globe Valves and Neway Gate Valves. Working models of many of the above products will be in operation so as to demonstrate their method of action.

Representatives: Charles W. Gill, general manager, in charge of exhibit; C. Wilson Gill, sales manager; Robert Bristow, Arthur Thomas, Fred Croes, factory representatives.

Aerofin Corp., Booth 14A
850 Frelinghuysen Ave., Newark, N. J.

Alexander Brothers, Inc., Booths 319-20
14 South St., Philadelphia, Pa.

Efficiency of Tentacular transmission belt will be shown under normal operating conditions as well as the features of construction and the methods of application of Tentacular belts for all classes of belt transmission. Charts, instruments and models will be special features of the demonstration.

Representative: J. L. deRabot, consulting engineer.

A. Allan & Son, Booth 92
Harrison, N. J.

This company will exhibit Allan Red Metal bushings and bearings, Allan Red Metal faced pistons, Allan Metal valve discs, and demonstrate other uses of this special packing, Red Metal and bearing bronze.

Representatives: Andrew Allan, William T. Allan, Henry Chandler.

Allegheny Steel Co., Booth 600
Brackenridge, Pa.

Material such as tubing, wire, rivets, screws and bolts of various alloys will be shown.

Representatives: F. L. Kennedy, New York manager; Clark W. Green, sales promotion; O. M. Otte, L. W. Hostettler, engineers.

Allen Mfg. Co., Booth A, Mezz. Fl.
133 Sheldon St., Hartford, Conn.

Complete line of socket head set and cap screws, shoulder screws, pipe plugs and tap extensions will be shown.

Representative: C. J. Mesiter.

Allen & Billmyre Co., Inc., Booths 213-4
Grand Central Palace, New York, N. Y.

Specialties for blowing, exhausting and vacuum cleaning will be shown here, including centrifugal blowers, portable and stationary, industrial vacuum cleaning systems and pneumatic conveyors.

Representative: J. F. Billmyre, president in charge.

Allen Bradley Co., Booths 558-60
Milwaukee, Wis.

Here will be found a general line of current control apparatus including No. 830 pressure switches and No. 840 float switches which are new developments. There will also be a manually-operated motor starting switch equipped with overload breakers which has just been announced and recent developments in control accessories will be included. These will be of particular interest to the oil burner trade and refrigerator manufacturers.

Representatives: F. F. Loock, general manager; G. A. Wilms, chief engineer; L. Matthias, director of research; C. N. Calkins, manager, New York office; M. H. Allenbeck, manager, Boston office; G. F. Pain, manager, Philadelphia office; P. R. Streeter, H. I. Search, G. H. Brewer, sales engineers, New York; A. F. Landergott, W. F. Mackey, sales engineers, Philadelphia.

Allen-Sherman-Hoff Co., Booths 62-3
225 S. 15th St., Philadelphia, Pa.

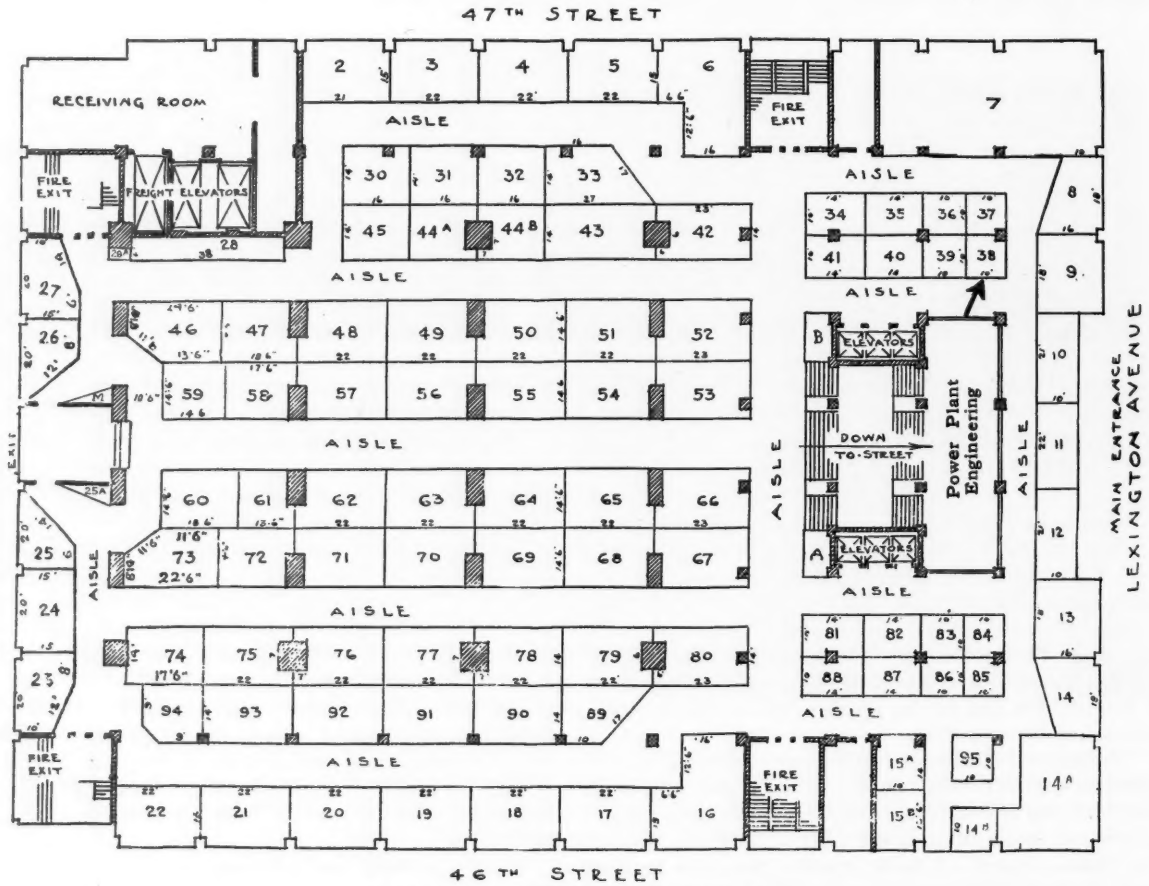
Hydroseal ash pump, Hydrovactor and Wind Swept valves will be displayed, for handling ashes, dust and fine materials to sump pits or for filling in low land.

Alsop Engineering Co.,
Booths 210ABC
39 W. 60th St., New York, N. Y.

American Air Filter Co., Inc., Booth 3M
First and Central Ave., Louisville, Ky.

Air filters of viscous and dry, automatic and unit types will be displayed by this company. A special feature of this exhibit will be a dust arrester and a window ventilator, both demonstrated in action.

Representatives: J. R. McConnell, H. C. Murphy, W. K. Gregory, W. G. Frank; J. F. Reed, New York representative.



PLAN OF MAIN FLOOR, BOOTHS 2 TO 95

Allen Air Appliance Co., Inc.,
Booths 241-3
452 Lexington Ave., New York, N. Y.

Products to be exhibited here will include the Triple A products, heavy duty pneumatic sweeping systems for factories and power plants, single and multistage centrifugal or turbo blowers and exhausters, heavy duty portable vacuum cleaners for industrial service. Among the new products and improvements will be a portable ash removal equipment by which ashes are drawn from the basement to a steel tank, which is separate from the suction unit so that the suction or power unit can be used with several ash-dump units.

Representatives: F. C. Allen, Jr., L. B. Hardtla, sales managers; William Fawcett, R. J. Heller, Eugene Failmezger, Thomas H. Smith, Clarence Farrell, H. M. Allen, R. Rappaport, A. L. Thurston.

American Arch Co., Booth 58
60 E. 42nd St., New York, N. Y.

American Blower Corp.,
Booths 314-5, 321-2
6000 Russell St., Detroit, Mich.

Apparatus exhibited will include a new Sirocco Series 30 induced draft fan and the New Series 30 American H. S. forced draft fan.

Representatives: Edward W. Legier, manager power plant department; Arthur Ritter, Herbert E. Barth, J. B. Leonard, W. Roeder.

American Brass Co., Booth 65
Waterbury, Conn.

Admiralty and Ambrac condenser tubes,

condenser head plates, Everdur metal, Anaconda welding rods, brass pipe and copper tubes for use with compression fittings, extruded shapes, die-pressed parts, rods, bars and segments, Anaconda sheet metal will constitute the exhibit in this space. Of special interest will be an exhibit of Everdur Metal, an alloy of copper, silicon and manganese, combining the strength of steel with greater resistance to corrosion than copper. This product will be shown in sheets, plates, strips, wire rods, tubes and ingots. Considerable interest is being shown at the present time in its use as a tank metal because it can be welded readily, the same as steel.

Representative: W. Harold Dowd, in charge.

American Car & Foundry Co., Booth 201
30 Church St., New York, N. Y.

Products to be shown in this exhibit will be the A. C. F. Three-Electrode Berwick electric rivet heater and the Single

American Gas Assn., Booth 7
420 Lexington Ave., New York, N. Y.

American Locomotive Co.,
Booths 227-8, 338-9
30 Church St., New York, N. Y.

American Metal Hose Co., Booth 206
Waterbury, Conn.

Flexible metal hose, metal tubing and metal conduit will be shown in a complete line, also various special types for special use in the industrial field, including the most recent developments of this product.

Representatives: John E. Locke, assistant secretary and assistant treasurer; E. B. Merriam, in charge; Arthur W. Cook, G. E. Bronson, John C. Bright.

American Propeller Co., Booth 429
220 Grindall St., Baltimore, Md.

Products to be shown will be propeller type exhaust fans and ventilating units. Description of the new product will be

safe to operate at 2,000 lb. pressure, made of Toncan metal and electrically welded.

Representative: Thomas S. Derr, president, in charge.

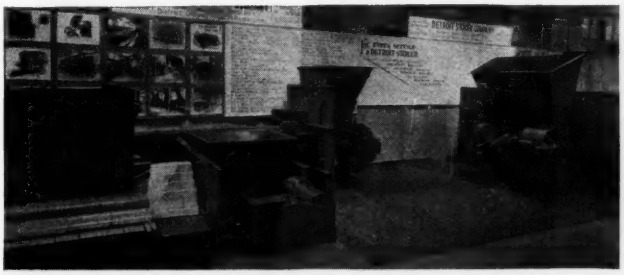
Ames Pump Co., Inc., Booths 225-8
90 West St., New York, N. Y.

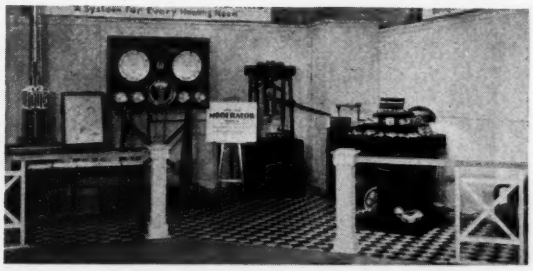
Vacuum Heating Pumps will be the product displayed in this space.

Representatives: Charles F. Ames, R. H. Frederick, A. H. E. Berchem, Richard Golden.

Amthor Testing Instrument Co., Inc.,
Booth 611
309 Johnson St., Brooklyn, N. Y.

Complete line of tachometers, portable and stationary, indicating and recording; portable and stationary tachoscopes, speed indicators, pressure gage testers, U gages, quadrant scales for various materials and other instruments of precision will be included in this exhibit. A special display will be made of ten different types of





Electrode Berwick electric metal (forging) heater. The rivet heaters in different sizes will take care of rivets from 5/8 to 1¾ in. in diameter and from 1 to 9 in. long, bringing them to 1700 to 1800 deg. temperature. Forging heaters are made in various styles and sizes and can be furnished for heating billets up to 5 in. in diameter and 4 ft. long or bars 1 in. in diameter up to 6 ft. long.

Representatives: F. C. Cheston, John S. Helt, Wilson Helt.

American Engineering Co., Booths 70-1
2412 Aramingo Ave., Philadelphia, Pa.

This company will exhibit a modern Taylor Multiple Retort underfeed stoker of a design which has been in operation for a year or more. All latest improvements will be shown and by means of convenient stairways it will be possible for visitors to see every working part of the big exhibit including the fin-type tuyeres, ram, drive, individual pusher rod mechanism, ash pit and crusher rolls. All parts except the crusher rolls will be in operation and under control, as if the stoker were installed in a central station. Other products of the company shown, will be successful auxiliaries which can be applied to stokers, pulverized coal, oil or gas fired boilers; also the Lo-Hed Hoist Division of the company will show its plain trolley hoist in operation.

Representatives: J. B. Copeland, New York manager, in charge; R. N. Ruiter, Birmingham; G. J. Zanke, Chicago; R. W. E. Leach, Boston; C. W. Baldwin, Philadelphia; W. H. Bixby, Des Moines; W. S. Major, Cincinnati; W. M. Chatard, A. M. Norris, Baltimore; J. H. DeVisser, Detroit; A. R. Robertson, St. Paul; E. V. Strickler, Cleveland; D. A. Polhemus, Pittsburgh.

distributed, this being the first time that these devices have been exhibited.

Representative: D. Lynn Churchwell.

American Pulley Co., Booth 437
4200 Wissahickon St., Philadelphia, Pa.

Here will be found a display of steel split pulleys, Sprucolite motor pulleys, V-belt sheaves, pressed steel hand trucks and case trucks, pressed steel shaft hangers and various accessories or parts of these different products.

Representatives: J. Smith Pratt, New York manager; G. H. Anderson.

American Radiator Co., Booth 544
40 West 40th St., New York, N. Y.

Complete line of automatic instruments will be shown suitable for regulation of temperature, pressure or vacuum. Motor-operated valves and solenoid valves will be exhibited here, also the Arcostat thermostat designed for use on street railway cars and electrically heated coaches. A special feature will be the new American Radiator Radiatherm control, an equipment for individual control of radiators of either direct or indirect types. Radiators will be shown of both types in cast iron and non-ferrous materials.

Representatives: C. J. Swan, assistant manager, accessories division; K. B. Thorndike, district manager, accessories division; R. S. Dawson, F. S. Bartlett, R. L. Campbell.

American Society of Mechanical Engineers, Booth 80
29 W. 39th St., New York, N. Y.

American Steam Automobile Co.,
Newton, Mass. Booth 406

An exhibit will be made of small steam boilers, burners and accessories; also a new type of small high-pressure boiler,

tachometers mounted on a stand attached and under power to show the method of indication and record. Tensile strength testers are a new instrument designed and constructed to conform with specifications approved by trade association testing committees and which make a written and permanent record of the specimen material being tested. The pressure gage testers are dead weight type, especially designed for ruggedness, accuracy and simplicity. The U gage is a new design recently placed on the market and exhibited for the first time. It is made of 1 piece, replacement in case of breakage being made without removing the gage from the apparatus. Quadrant scales are made for testing foil, paper, tissue paper, board, cellophane, and other sheet materials.

Representative: Harvey Spence, in charge.

Anaconda Copper Mining Co., Booth 65
25 Broadway, New York, N. Y.

Appleton Electric Co., Booth 510
1701 Wellington Ave., Chicago, Ill.

Products shown in this exhibit will be Unilets, of no-thread and threaded types, Reelites, constant duty Reelites and other electrical specialties. Improvements will be demonstrated of the no-thread type Unilets for thin wall conduit, also several advances in the constant duty Reelites. Floodlights for interior and exterior have been added to the electrical specialties of this firm.

Representatives: F. H. Merrill, vice-president; L. P. Swick, H. H. Park, A. Ingald, W. H. Chambers, W. H. Flandreau.

Armstrong Cork & Insulation Co.,
Lancaster, Pa. Booths 277-8

Representatives: J. L. Allison, A. B.

Alexander, R. S. Broas, C. A. Senter, R. W. Winslow, E. C. Lloyd.

Armstrong Machine Works, Booth 271
Three Rivers, Mich.

Armstrong steam traps, as manufactured by this company, will be exhibited in a complete line, including the standard cast iron trap, forged steel trap for high pressures and compound steam traps for handling large quantities of water at high pressures. The company will also exhibit a glass model of the Armstrong trap operating on 5 lb. steam pressure, showing the entire cycle of operation of the inverted submerged-bucket, body as well as bucket being of glass. The quick action of the valve and self-scrubbing action of the trap will be evident. For the first time there will be shown an improved and simplified piston operated trap for handling large volumes of condensate or other liquids at high working pressures.

Representatives: A. E. Armstrong, president; T. H. Rea, sales manager; O. E. Ulrich, factory representative; C. W. Gill, New York.

Ashton Valve Co., Booth 38
161 First St., Cambridge, Boston, Mass.

Pop safety and relief valves, indicating and recording pressure and vacuum gages, master pilot pressure gages with illuminated dials, dead-weight gage testers and kindred instruments will make up the display. Special features will be large single and double illuminated master pilot gages, high-pressure exposed spring cast steel pop safety valves for saturated or superheated service, and double-area, dead-weight gage testers, all of improved design.

Representatives: Harry H. Ashton, sales manager; C. W. Buckelew, New York manager; C. J. Burrage, C. W. Ulrick.

Associated Alloy Steel Co., Booth 447
1806 Union Trust Bldg., Cleveland, Ohio.

Fabricated parts made of Nirosta KA-2 and other stainless steels will be displayed here.

Representatives: P. L. Coddington, New York district manager: D. B. Carson, C. B. Boyne, H. A. DeFries, W. Weaver, R. P. J. McCarty, G. Wilson, K. G. Reynolds.

Atwood & Morrill Co., Booths 552-3
Salem, Mass.

Here will be shown bleeder valves of the oil-closing-cylinder type, combination regulators, outside-spring-loaded valves, as well as other special items. Several improvements will be demonstrated in bleeder valves and in spring loaded relief valves.

Representatives: C. P. Atwood, B. T. Atwood, secretary, in charge; Alex V. Hose, chief engineer; R. George Ward, Philadelphia.

Automatic Switch Co., Booth 551
154 Grand St., New York, N. Y.

Control devices of the Asco line will be demonstrated here, including automatic transfer and remote control switches, multiple circuit switches, relays, contactors, solenoid operated valves and the like. One of the company's latest developments is an automatic transfer switch for changing over busbar connections. Also several new types of Superior solenoid valves will be featured for low, moderate and high pressures with automatic shut-off.

Representatives: W. F. Hurlburt, Louis Schwab, C. W. Valentine, F. M. Vogel.

Babcock & Wilcox Co., Booths 50-5
85 Liberty St., New York, N. Y.

The Babcock & Wilcox Co. and the Babcock & Wilcox Tube Co. will have their exhibits in their booths in connection with the Bailey Meter Co. and Fuller-Lehigh Co. The Babcock & Wilcox Co. will show samples of new welding technique developed by it, also a line of refractories including firebrick in standard weight and light weight classes, refractory insulating brick and refractory cements and plastics. The Babcock & Wilcox Tube Co. will show Polished Nirosta KA2 tubing and other iron-chrome-nickel alloy tubes and pipes; also cast chrome iron pipe, iron-chrome-nickel alloy castings, steel and Toncan tubing.

Representatives: For Babcock & Wilcox Co., Hosea Webster, New York sales manager; Dr. S. J. Crooker; for Babcock & Wilcox Tube Co., W. W. Eaton, sales manager; A. R. McAllister, H. B. Allen, W. O. Schroeder, J. F. Brett.

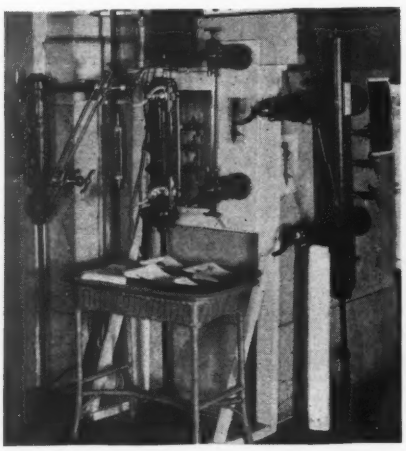
E. B. Badger & Sons Co., Booths 565-6
Boston, Mass.

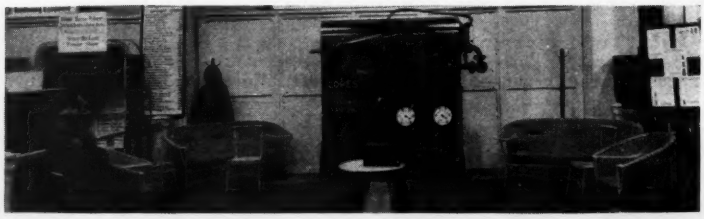
This company's exhibit will contain various types of expansion joints such as the Badger self-equalizing in both flanged and welding types, also the single and multiple-corrugation low-pressure expansion joints. A special feature will be a new type of copper hot water storage tank.

Representatives: H. W. Coombs, sales manager; F. R. Heath, A. R. Lawrence, F. E. Lyons, W. R. Styles.

Bailey Meter Co., Booths 51, 54
1050 Ivanhoe Rd., Cleveland, Ohio.

Here will be found an exhibit of power plant metering, control and regulating equipment. Three large steel plate panels will be shown with Bailey Boiler Meters, fluid meters, temperature recorders, multi-pointer gages and remote indicators. Also will be shown the Bailey Thermo-Hydraulic feedwater regulator which incorporates a fully balanced tight seating V-port regulating valve. Demonstration will be made of the various drives, switches, valves, contactors and other elements of the equipment, a displayer being used mounted with diagrammatic layouts, photographs and meter chart records made by Bailey meters.





Representatives: H. M. Hammond, manager of sales and engineering, in charge; H. C. Wheaton, manager, New York branch; W. L. Paulison, H. Beaman, R. M. Cundiff, C. S. Burnett, R. F. Tinsley.

Baldwin Duckworth Chain Corp.,
Worcester, Mass. Booth 479

Ballwood Co., Booths 221-2
30 Church St., New York, N. Y.

Barco Manufacturing Co., Booth 247
1801 Winnemac Ave., Chicago, Ill.

Barco flexible joints, lubricated plug valves and lubricated service and curb cocks will be shown with operating models. The lubricated service and curb cocks are an entirely new design, exhibited for the first time in the power plant industry. They are made for air or water pressure up to 100 lb. and for gas or gasoline pressure up to 50 lb. in the curb cock design. The lubricated plug valves are suitable for pressures from 150 up to 500 lb. The flexible joints in sizes from ¼ in. up to 6 in. are particularly used for pipes which are subject to considerable vibration, which are slightly out of line or make unusual angles in the course of the run.

Representatives: A. S. Lewis, New York district manager; J. T. Ross.

Barnes & Jones, Booths 312-3
128 Brookside Ave., Jamaica Plain, Boston, Mass.

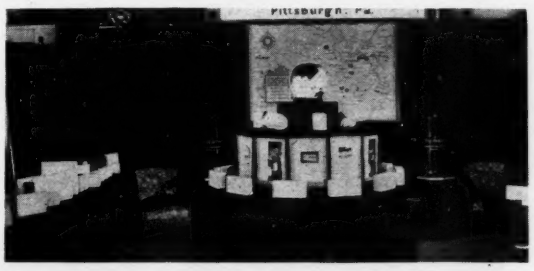
Heating systems will be shown including modulation, vapor and vacuum types; traps will be displayed of thermostatic radiator, vacuum return, blast, boiler return, and vent types; valves for steam and water modulation will be demonstrated.

Representatives: Walter E. Barnes, William T. Jones, H. B. Eells.

Bauer & Black, Booths 477-8
2500 S. Dearborn St., Chicago, Ill.

Bausch & Lomb Optical Co. Booth 602
Rochester, N. Y.

Optical devices will make up the exhibit in this booth, including a contour taking photographs of the structure of pure metal and alloys; also toolmaker's measuring projector and large photomicrograph apparatus for examining and microscope for the examining and measuring of all kinds of tools, screws and other metal parts to be manufactured with accuracy and uniformity; optical



comparator with accurary of reading to 0.00005 in., used for checking up parts produced in large quantities as to accuracy; optical indexing device for correcting any inaccuracies that may occur in a dividing head; bevel protractor for setting up angular work within one minute of arc; drill gage for checking the accuracy of the angle of cutting lips of a drill, as well as location of center and location of web of twist drills; thread profile gage to assure accurate thread cutting on lathes for inside or outside threads of small or large dimensions; centering level for setting up of cylindrical work with relation to milling cutters, gear cutters, saws or drills; demonstration of the latest shop microscope for inspection of quality or defects in metal surfaces, such as edges of cutting tools, the diameters of small holes and impressions in hardness tests.

Representatives: E. H. Anthes, assistant manager; J. A. Scheick, New York.

H. Belfield Co., Booth 550
435 N. Broad St., Philadelphia, Pa.

Steam specialties in a complete line including gland-packed, steam jacketed cocks, regulating valves for high and low pressure, Schaefer bypass valves and a general line of brass fittings will be shown. New features to be displayed will be the Rotary Shaft regulating valve made to replace the present regulating valve in fields where the material handled has a tendency to follow out on the stem and cake. In the new valve this following out is eliminated. Also there will be shown the Equipoise regulating valve for use where high velocities or high pressures are to be handled. This has disc balanced so that there is no side thrust against the valve body seats, thus eliminating friction and unnecessary wear. These valves will be shown in steel and iron for standard and extra heavy pressures. The Schaefer bypass will be displayed in sizes from ½ in. to 2 in. standard and extra heavy pressures, the object being to cut down the number of joints in the bypassing of a piece of equipment.

Representatives: F. R. Goehring, Edward Price, T. L. Smith, W. Barnhurst, J. Newman, F. M. Carroll.

Bernitz Furnace Appliance Co., Booth 78
89 Broad St., Boston, Mass.

Bernitz S-100 Carbofrax air-cooled blocks for stokered boiler furnaces, also Carbofrax floors and walls for pulverized fuel and oil burning furnaces and the Bernitz Nygaard coverage for water-cooled furnace walls, including Carbofrax and cast iron blocks will constitute the exhibit here. A typical installation will be shown of the air-cooled blocks provided with an actual air circulation to illustrate the effective cooling obtained by the Bernitz type of construction. Several new improvements have been made in the Nygaard water wall coverage which will be on exhibit, also there will be shown the application of Bernitz super linings for water gas generators.

Representatives: Arthur E. Smith, president and general manager; Oscar Nygaard, chief engineer, Chas. H. Schroder, Philadelphia district manager; Fred G. Schneeberg, Jr., New York district manager; Benjamin H. Snow, sales engineer.

Biax Flexible Shaft Co., Booth 508
22-14 40th Ave., Long Island City, N. Y.

Complete line of flexible shaft units will be shown of the following types: Diesinkers equipment for rotary filing, high speed grinding, polishing and buffing; heavy grinding and snagging units, single or three speed; sanding machines of drum and disc type; portable sheet metal shears; screw driving machines.

Representatives: R. Wezel, president; F. I. VanderBeek, Jr., vice president; G. M. VanderBeek, secretary and treasurer.

L. C. Biglow & Co., Inc., Booth 266
250 West 54th St., New York, N. Y.

Scully-Jones production tools including tap and cutter chucks, floating and self-aligning reamer holders, counterbore and spot facing tools will also be displayed as well as Davis boring tools including micrometer adjustable and block type bars and cutters, reamers, fixtures, and the like.

Bilgrim Machine Works, Inc., Booths 491-2
1235 Spring Garden St., Philadelphia, Pa.

The Black & Decker Mfg. Co.,
Towson, Maryland. Booths 520-2

This display will include the Van Dorn electric and portable tools and the Marschke Manufacturing Co.'s products now marketed under the name of Black & Decker-Van Dorn High Cycle and Heavy Duty Grinder lines. One of the outstanding features will be the 18-in. grinder and the new selective speed independent spindle buffer. Adjustable clutch nut runners and a light compact 3/16-in. drill and adjustable clutch screwdriver will also be featured. The various tools will be shown in operation during the show.

Representatives: E. M. Stuart, New York manager, L. M. Boyd, G. F. Fischer.

Boig & Hill, Inc., Booth 250
180 Washington St., New York, N. Y.

Boiler Engineering Co., Booth 450
24 Commerce St., Newark, N. J.

Beco-Turner baffle walls will be featured, with corrugated sheet metal separators to provide for expansion. Advantages of angular baffling will be demonstrated. Also will be shown Beco-Turner tube blocks and photographs of installations.

Representative: J. W. Putnam, in charge.

Charles Bond Co., Booth 561
617 Arch St., Philadelphia, Pa.

Bond Foundry & Machine Corp.,
Manheim, Pa. Booth 562

Bonney Forge & Tool Works,
Allentown, Pa. Booths 650-1

Borden Co., Booths 248-9
Warren, Ohio.

The entire line of Beaver time and labor-saving die stocks, pipe cutters and power drives will be shown with all products demonstrated and the power drive in constant operation. New Beaver products to be displayed will be Four-post die stocks in sizes from 1 to 2 in., 3-way Beavers in sizes ⅜ to 1 in., the No. 104 Square End pipe cutter for sizes from 2½ to 12 in. pipe, a Power Drive with universal motor and other improvements, an improved No. 41 die stock, improved small ratchet tool, new ratchet tool for threading bolts from ½ to 2 in. diameter and bolt die heads for the No. 3 Beaver Jr. ratchet die stock.

Representatives: E. R. Barkley, assistant sales manager, in charge; Paul Knauff, New York manager.

Boston Gear Works Sales Co.,
Booths 326-31
Norfolk Downs, Quincy, Mass.

Botfield Refractories Co., Booth 94
Swanson & Clymer Sts., Philadelphia, Pa.

All the company's line of Adaproducts

will be exhibited, including Adamant fire brick cement, Adachrome fines, Adachrome aggregate and plastic supercement, Adapatch and the Adamant gun for application of plastic refractories.

Representatives: A. H. Engstrom, sales manager, in charge; C. C. Phillips, New York; S. C. Lott, New England; W. B. Smith, Midwest.

S. F. Bowser & Co., Inc., Booth 620
Fort Wayne, Ind.

Typical installations of Bowser equipment will be shown in this booth by an exhibit of photographs of lubricating, filtering, clarifying, storing and measuring apparatus as installed for oil, gasoline and other liquids.

Representatives: L. W. Kohler, manager of lubrication and filtration division; E. M. May, New York; K. E. Paulus, Boston.

Bradley Washfountain Co. Booths 403-4
2203 Michigan St., Milwaukee, Wis.

This exhibit will feature the newest type of Bradley Washfountain as used by printers, railway systems and power plants. Included in the exhibit will be found a Bradley bubbler, constructed of materials similar to the Washfountain, and literature describing sanitary requirements of washrooms.

Representative: A. C. Cooper.

Breuer Electric Mfg. Co., Booths 463-4
844 Blackhawk St., Chicago, Ill.

Bristol Co., Booth 12
Waterbury, Conn.

Complete assortment of Bristol's instruments for power plant use will be shown, featuring refinements and mechanical improvements; indicating and recording instruments for pressure vacuum, temperature, electromotive force, current, power and the like.

Representative: G. H. Gaites, chairman of the power plant committee.

Brooklyn Borough Gas Co., Booth 7
W. 17th St. & Mermaid Ave., Coney Island, N. Y.

Brooklyn Union Gas Co., Booth 7
180 Remsen St., Brooklyn, N. Y.

Brown Instrument Co., Booth 49
Philadelphia, Pa.

This exhibit will feature an interesting educational display of a Brown Electric Flow Meter manometer, also indicating and recording instruments measuring flow through a pipe circuit, part of which is made of glass so that the flow through the orifice can be observed. The orifice plate is made of glass so the action of entrained air bubbles on either side of the orifice as the liquid rushes through will be visible showing the conditions which produce the differential pressures on which the operation of the meter depends. A U-tube connected across the orifice will show this differential pressure and flow can be varied so that the relations between flow and differential pressure can be demonstrated. Another feature will be a sectional view of a Brown Flow Meter manometer showing the changeable range tube and simplicity of construction. This will occupy the central panel of an instrument board containing four other sections, featuring respectively thermometers for power plant temperatures, pyrometers for stack and furnace temperatures, flow meters for steam, water, air, oil and gas also recording gages for pressure, liquid level, CO_2 and other miscellaneous operating features in power plants. In the thermometer panel, resistance and pressure type thermometers will be shown; in the pyrometer display, indicating and recording pyrometers for measuring flue gas and superheated steam, also a special pyrometer for indicating and comparing Diesel engine cylinder exhaust; flow meter panel will have the indicating model and circular chart recorder model, also strip chart recording flow meters of single record and duplex type.

Representatives: R. P. Brown, president; George W. Keller, vice-president and general sales manager; C. H. Kerr, vice-presidnt and general manager; J. P. Goheen, secretary-treasurer; E. B. Nichols, chief engineer; M. M. Watkins, G. W. Goodman, R. F. Roberts, Joseph Lewis, A. H. Koch, New York district representatives.

Buffalo Forge Co., Booths 413-4
Buffalo, N. Y.

One product to be shown is the Buffalo induced draft fan with water-cooled bearings. Other features in the exhibit will be Buffalo unit heaters, a Buffalo Universal Iron Worker, and a Class SL centrifugal pump made by the Buffalo Steam Pump Co. Of interest among the equipment shown will be a new model B Breezo-Pin unit heater and a new gas-fired unit heater, these being shown in operation.

Representative: O. S. Ryan, in charge.

Builders Iron Foundry, Booth 28
9 Codding St., Providence, R. I.

Venturi meters and shunt meters for steam, air and gas will be displayed at this exhibit.

Representatives: A. M. Hammond, Providence; D. J. Purdie, New York district manager; A. A. Wood, Philadelphia district manager; F. A. Merlo, New York, W. S. Codell, Philadelphia.

Building Specialties Co. Inc., Booths 244-5, 283-4
22 Clinton St., Brooklyn, N. Y.

Bundy Steam Trap Co., Booth 8
39 Elm St., Nashua, N. H.

Andrew C. Campbell, Inc., Booths 344-5
Bridgeport, Conn.

Here will be shown Abrasive Cut-off machine and Campbell Nibbling machines in operation, demonstrating their use for shaping plate metal work.

Representative: Robert Powell, in charge.

Carborundum Co., Booths 21-2
Perth Amboy, N. J.

This exhibit will include Carbofrax, Carborundum Brand Silicon Carbide brick, tile, special shapes and refractory cements suitable for use in boiler furnaces and similar power generating units. There will also be shown photographic and actual reproductions of installations to illustrate various types of water-cooled, air-cooled and solid Carbofrax furnace wall construction.

Representatives: C. E. Hawke, general sales manager; J. G. Fritzinger, J. A. King, F. W. Miller, H. J. Ransley, sales engineers.

Carrier Engineering Corp., Booth 14A
850 Frelinghuysen Ave., Newark, N. J.

Carrier Lyle Corp., Booth 14A
850 Frelinghuysen Ave., Newark, N. J.

A. W. Cash Co., Booth 273
3rd and Eldorado Sts., Decatur, Ill.

Celite Corp., Booth 12
1320 S. Hope St., Los Angeles, Calif.

Centrifix Corporation, Booth 203
3029 Prospect Ave., Cleveland, Ohio.

This company's display will include Centrifix purifying equipment for steam, vapor, gas and air.

Representatives: D. L. Darnell, sales manager; Harry A. Smith, manager marine department; John Degan, Mr. Gordon, marine department; F. W. Linaker, New York manager; C. H. Baker, P. Richardson, sales engineers, New York.

Century Electric Co., Booths 540-1
1806 Pine St., St. Louis, Mo.

Three types of motor lubrication will

be shown including the Century Wool Yarn system for sleeve bearings, the oil ring system for sleeve bearings and ball-bearing grease lubrication. In addition will be exhibited horizontal and vertical motors in single-phase, polyphase and direct-current types. As special features will be shown totally-enclosed motors, plain, fan-cooled and for vertical installation.

Representative: Oliver S. Imes, publicity department.

Chapman Valve Mfg. Co., Booths 46-7
Indian Orchard, Mass.

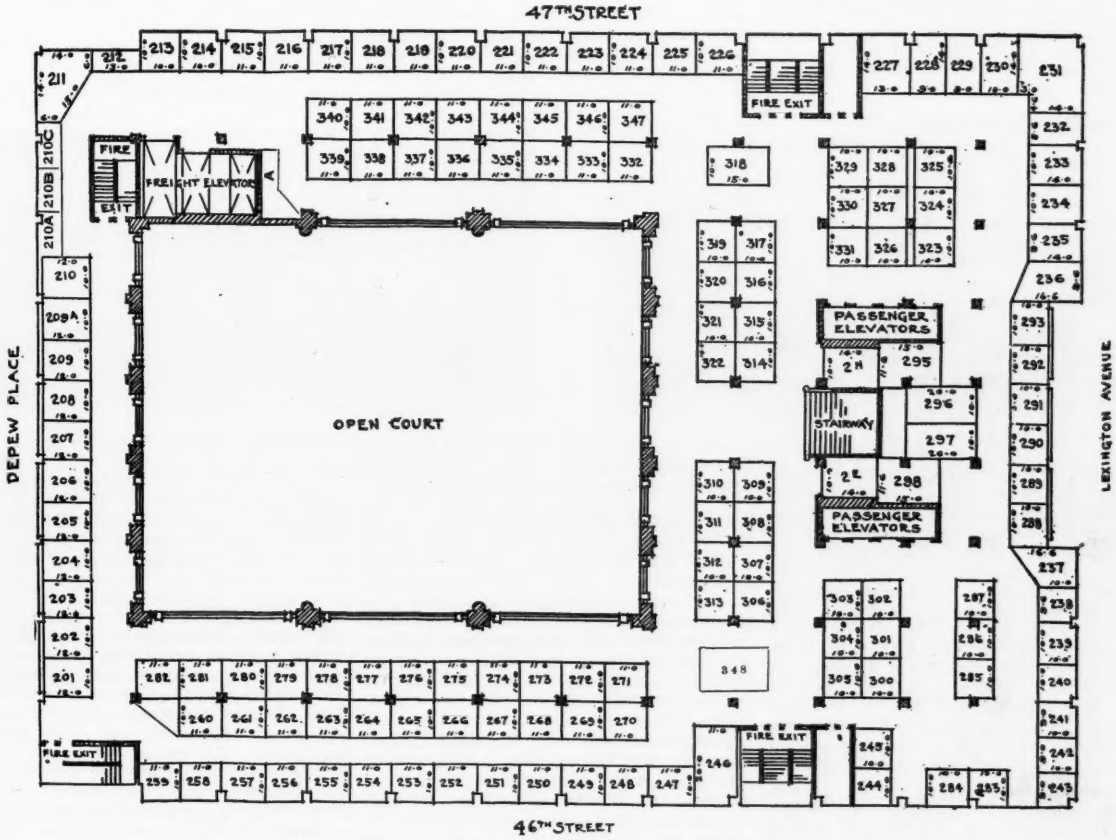
A full line of Chrome Tungsten Steel valves and fittings wil be displayed, also a working model of the Chapman motor hoist and the Hi-up wire rope electric hoist. The last named is to be announced first at this show, the design being to permit its use under extremely low-head conditions. The ¼-ton hoist requires only 13 in. from the bottom of the runway beam to the bearing point of the lower hoisting hook. It is designed for extreme simplicity, is furnished with lug suspension for stationary mounting or with ball bearings for push type trolley. Non-friction bearings and a magnetic brake contribute to accurate control and ease of operation.

Representatives: D. S. Brisbin, vice-president in charge of sales; F. W. Shaw, sales manager; W. J. Koch, district sales manager.

Cling-Surface Co., Booth 511
1032 Niagara St., Buffalo, N. Y.

Here will be found the Cling Surface demonstrating machine which shows the increased efficiency of a belt treated with Cling Surface over untreated belts. The machine includes a 7½-hp. motor driving a 4-kw. generator through a system of 3-in. light, double-ply leather belts, one treated and the other untreated, running from 16-in. to 6-in. pulleys on 5-ft. centers. The demonstration will prove how little belt tension is required when Cling-Surface is used.

Representatives: Gordon N. Parker, vice-president, in charge; W. F. Lauffert, New England representative.



PLAN OF SECOND FLOOR, BOOTHS 201 TO 348

unit for electrical control of gate valves, sluice gates, floorstands, and the like.

Representatives: Thomas F. Maher, manager of sales, in charge; Earnest Cochran, New York manager; Vincent T. Malcolm, chief metallurgical engineer.

Chicago Pipethread Machine Co.,
Racine, Wis. Booth 529

Chicago-Wilcox Mfg. Co., Booth 272
7701 Avalon Ave., Chicago, Ill.

Chisholm-Moore Hoist Corp.,
Tonawanda, N. Y. Booth 526

In this exhibit the company will include chain hoists of the Cyclone spur-geared, ball-bearing, the Standard screw-chain and the Blue Boy differential types. I-Beam trolleys will be shown in the Matchless Timken-bearing and Moore ball-bearing types, also the C-M electric wire rope hoist, the Cyclone electric chain

Cities Service Oil Co., Booth 418
60 Wall St., New York, N. Y.

Clements Mfg. Co., Booth 563
601 Fulton St., Chicago, Ill.

Complete line of industrial blowing, suction cleaning and spraying equipment will be displayed, including the Clements Cadillac portable electric blowers of various models with standard attachments and special tools. A display board will show all the different parts of the Cadillac blower; a special Cadillac auto cleaner will be demonstrated, also the latest improvements in cleaning and spraying equipment.

Representatives: C. A. Bremmer, manager blower division, in charge. William H. Cline, New York representative; G. S. Githens, New England representative.

Cleveland Worm & Gear Co.,
Booths 20-1
3249 E. 80th St., Cleveland, Ohio.

Clipper Belt Lacer Co., Booth 265
Grand Rapids, Mich.

Complete line of Clipper apparatus will be shown including various models of belt lacers, fasteners, connecting pins and cutters. No. 6 and 8 Clipper Speed lacers are the latest additions to the line.

Representatives: Wylie C. Lee, president, John Jepson, in charge.

Cochrane Corporation, Booth 67
17th St. near Allegheny Ave., Philadelphia, Pa.

One product of this company which has been introduced extensively during the last year is the Cochrane all steel tandem blowoff valve. The company's lines and apparatus will be fully illustrated by pictures and smaller apparatus will be demonstrated by actual equipment.

Representatives: J. C. Jones, general manager; H. E. Sibson, vice-president and

general sales manager; A. B. Wallem, secretary and general works manager; J. D. Yoder, manager softener division; C. E. Joos, manager steam purifier division; O. H. Woolford, manager flow meter division; V. A. Rohlin, chief engineer; J. B. Fowler, manager inspection and service department; Frank M. Patterson, manager boiler blowoff valve division; George H. Gibson, advertising manager; W. W. Montalvo, Jr., Fred Sage, A. R. Foote, Chas. Willard, New York; E. Greene, Boston; J. D. Berg, Pittsburgh; Fred Mason, Detroit; H. J. Meier, Chicago.

A. C. Colby Machinery Co., Booth 401
183 Centre St., New York.

Products here shown will include a 16-in. Toolroom lathe, 9-in. motor-driven lathe in operation, and a 9-in. motor-driven bench lathe on maple bench.

Representatives: A. C. Colby, L. O. Stephenson, H. J. Sorenson, L. W. Weiner.

Colson New York Branch, Inc., Booth 506
7 E. 19th St., New York, N. Y.

Columbus McKinnon Chain Corp.,
Tonawanda, N. Y. Booth 526

Combustion Engineering Corp. Booths 23-5
200 Madison Ave., New York, N. Y.

Sectional headers for 1400 lb. pressure will be shown, a welded drum, samples of welded bends, a section of the C-E return bend economizer, one of the pressed heads for installation at Brooklyn Edison Co., model of C-E air preheater and the new C-E stoker unit for small boilers. This stoker unit model will be complete, showing agitating grates, dump grates and automatic ash ejector. It is applicable for power boilers of 125 hp. at rating and heating boilers from 8,000 to 15,000 sq. ft. capacity. Large panels will show high-pressure units at the Ford Motor Co. factory, Milwaukee Electric Railway and Light Co., units at East River Station of the New York Edison Co., producing over 1,250,000 lb. of steam each per hour, Brooklyn Edison Co. boiler units, Georgia Power Co. pulverized fuel installations, Pittsburgh Steel Co.'s direct fired pulverized fuel unit, the Bethlehem Steel Co.'s steam generator unit and other interesting installations.

Representatives: John Van Brunt, James Cleary, Dr. Henry Kreisinger, George Jackson, A. C. Weigel, Edwin Lundgren.

Connery & Co., Booth 43
Second St., above Erie Ave., Philadelphia, Pa.

Connery's Improved Expansion Stiffener showing its application in connection with breechings and duct work will be shown, also the Company's air-cooled damper, Improved Expansion stack connection and the application of guide vanes in duct work.

Representatives: William M. Connery, president; E. C. Aucott, secretary; A. D. Stewart, C. B. Nicholson, W. E. Gaunt, Jr., W. J. Henderson.

Consolidated Gas Co. of N. Y., Booth 7
4 Irving Pl., New York, N. Y.

Consolidation Coal Co., Booths 628-9
15 Broad St., New York, N. Y.

Representative display will be made of bituminous coals mined in the company's six mining divisions on the eastern United States, including Pennsylvania, Maryland, northern West Virginia, Pocahontas and eastern Kentucky regions.

Representative: J. M. Dougherty, assistant to vice-president, in charge.

A. C. Cooper Sales Co., Booth 418
122 E. 42nd St., New York, N. Y.

Cooper-Hewitt Electric Co., Booth 4
410 Eighth St., Hoboken, N. J.

Crandall Packing Co., Booth 527
Palmyra, N. Y.

Full display of the company's products will be made. This will include asbestos, rubber, duck, flax, cotton, metallic and other packings for service on steam, water, air ammonia and gas, the packings shown being particularly designed for every purpose. Two recently established packings are the Travgargran, which may be constructed of duck or asbestos for the service required and is for hydraulic installations; also there will be samples of Crandite rings, a new equipment for service against hot water.

Representaives: F. H. Granger, general sales manager; E. P. Watrous, New York manager, in charge.

Crane Packing Co., Booths 261-2
1800 Cuyler Ave., Chicago, Ill.

Products to be displayed in this exhibit will be metallic and semi-metallic packings, as well as a full line of metallic condenser packings. Notable as new products will be the High temperature superheat packing sets and hot oil packing sets.

Representatives: F. E. Payne, Newell Brackett, Thomas Munro, Harry Taylor.

Crew-Levick Co., Booth 418
400 N. Broad St., Philadelphia, Pa.

Crosby Steam Gage & Valve Co.
10 Roland St., Boston, Mass. Booth 44-B

Here will be shown a power station gage board on which will be mounted various types of pressure indicating and recording gages. A special feature will be a sectioned high-pressure nozzle type pop safety valve, style HNA, a section of this valve being cut out to show clearly the internal parts and construction of the valve.

Representatives: Carl F. Woods, president; G. F. Felker, vice-president and sales manager, in charge; J. J. Bresnahan, assistant to the vice-president; A. W. Lenderoth, eastern sales representative.

Dampney Company of America, Booth 62
Hyde Park, Boston, Mass.

This company will exhibit its complete line of Apexior protective coatings for metal surfaces and will show equipment that has been developed for applying it expeditiously to the internal surfaces of boilers, economizer and condenser tubes. Two grades of Apexior will be seen here, No. 1 a thin smooth paint-like material for surfaces to be heated above 175 deg.; No. 3 for application on surfaces exposed to cold wet conditions under 125 deg. and to hot dry conditions up to approximately 450 deg. For application a complete line of revolving brushes to be used on the end of an air-driven tube cleaner has been developed to coat the inner surface of shells and tubes.

Representatives: E. F. Gilbert, president; H. P. Kauffman, sales department, E. L. Clark, Boston, W. H. Caldwell, J. W. Hartley, marine sales, New York; C. J. Hunter, Philadelphia.

Dardelet Thread Lock Corp., Booths 296-7
120 Broadway, New York, N. Y.

The Dardelet Thread principle and its application to nuts, bolts, screws and other threaded parts will be demonstrated and special applications of the thread shown for valve tappets, cable connectors and the like.

Representatives: L. C. Sprague, executive vice-president; A. Morris Thomson, vice-president in charge of engineering; Charles J. Gass, secretary; William E. Hoke, consulting engineer, Norman C. McLoud, executive representative; W. L. McKay, F. D. Moore, sales promotion engineers.

Davis Boring Tool Co., Booth 266
St. Louis, Mo.

Payne Dean, Booth 16
17 E. 45th St., New York, N. Y.

Dearborn Chemical Co., Booth 13
310 So. Michigan Ave., Chicago, Ill.

Samples of various consistencies of No-Ox-Id rust preventive will be exhibited with demonstration of its operation. Also copies of a new book entitled Scientific Water Correction will be distributed, covering the treating of boiler feedwater supplies. Other material will be available in regard to water treatment.

Representatives: Edward C. Brown, vice-president and eastern manager; S. H. Opdyke, assistant to vice-president and eastern manager; C. A. Remsen, eastern manager department of specialties; W. H. Kinney, T. H. Platt, F. M. Tibbetts, G. W. Carr.

DeBothezat Impeller Co., Inc., Booths 423-4
1932 Park Ave., New York, N. Y.

Equipment exhibited in this space will include a new type impeller blower of multiple stage disc construction for high pressure and high air deliveries at low speed; a 36-in. man cooler with nozzle mounted on portable stand with long range discharge; a new floor-ceiling type unit heater; a bifurcator pressure disc fan for use inside of ventilating duct with the motor located outside; specially built fans for industrial applications, kitchen fans, Ozone Breeze machine, telephone booth ventilating equipment; also railroad car ventilation. Of special interest will be the disc fans for giving static pressure and high efficiency and experimental demonstrations of these characteristics and non-overloading power characteristics of disc pressure fans.

Representatives: A. G. Nichols, manager; R. F. Ruggles, sales manager.

Julian d'Este Co., Booth 21
Cambridge & Spice Sts., Boston, Mass.

Curtis engineering specialties will be exhibited here in stock and special sectioned models, including a complete line of pressure reducing valves, damper regulators, temperature regulators and pump governors; also return and non-return steam traps, of bucket and float types. Special features will be a new Curtis type T return trap, the Curtis balanced float type steam trap and the d'Este bucket trap.

Representatives: D. A. Herrick, general manager, in charge; W. T. Hill, Joseph Meyer; George Bezanson, superintendent.

A. P. deSanno & Son Booth 459
1615 McKean St., Philadelphia, Pa.

Radiac Cut-off machines and grinding

wheels will be shown here and their operation demonstrated.

Representatives: B. G. Hardy, S. M. Hershey.

Detroit Seamless Steel Tubes Co.,
Detroit, Mich. Booth 229

DeWalt Woodworking Machinery Corp., Booths 655-6
1775 Broadway, New York, N. Y.

Diamond Chain & Mfg. Co., Booth 316
Indianapolis, Ind.

Mounted on two heavy tables will be roller chain drives actuated by electric motors of standard speeds, showing single and multiple strand chain, the tables being painted black and all metal parts, except the chain, chromium plated. Display will also be made of samples of various attachments as well as models of the Clark Flexible Coupling.

of Economy grease, a lubricant of high grade will be exhibited, also samples of grease suitable for ball and roller bearings, chain drives and for grease guns.

Representative: Theodore M. Atkinson, sales manager.

The Electric Storage Battery Co.,
Allegheny Ave. and 19th St., Philadelphia, Pa. Booth 428

Exide Batteries designed for various uses in power plant operation will be shown, as well as details of construction and methods of application.

Representatives: H. H. Hudson, E. G. Beutter, H. H. Warren, D. E. Weaver, J. W. Weight, E. M. Sansom, W. H. Plauth, J. B. Clark, A. G. Hunter, W. O. Hahne.

Electro Anti-Corrosive Corp., Booth 481
140 Cedar St., New York, N. Y.

Kirkaldy electrolytic system for prevention of corrosion and scale on water surfaces of boilers will be demonstrated.

Representatives: Alexander Kirkaldy, vice-president and consulting engineer; Benjamin C. Donham, vice-president; J. A. Fincken, E. G. Hohn, engineers.

Everlasting Valve Co., Booth 41
1 Exchange Place, Jersey City, N. J.

Valves of all descriptions will make up this display, the main features including Everlasting valves, Companion angle valves, special water column valves and duplex blowoff unit. Of interest will be the Everlasting special valve for 500 lb. pressure and the Companion angle valve for light pressure.

Representatives: John H. Allen, president; Wylie G. Wilson, consulting engineer; E. N. Corning, sales engineer; George M. Elton, Jr., Edward Boll, S. I. Anderson, home office sales staff.

The Fafnir Bearing Co., Booth 246
New Britain, Conn.

A large range of types and sizes of standard commercial ball bearings, together with their application in power transmission equipment will be demonstrated here. New developments and improvements during the year will be shown covering special bearings of all kinds.

Representatives: C. F. Stanley, Industrial sales manager; D. M. Davidson, advertising manager; D. J. Gilbert, New York manager; George Barenborg, Newark manager; R. W. Powell, H. C. King.

Representatives: W. B. Haislup, H. I. Markey, J. L. Wamsley, R. M. Barwise, A. H. Barwise.

Joseph Dixon Crucible Co., Booth 254
Jersey City, N. J.

Dri-Steam Valve Sales Corp.,
70 E. 45th St., New York, N. Y.
Booths 209, A-10

Products shown here will include Dri-Steam valves and driers of many types and for different conditions.

Representatives: J. H. Nash, Sr.; Albert DeChiara, Pasquale Pascale, A. L. Rhodes.

Struthers Dunn, Inc., Booth 528
139 N. Juniper St., Philadelphia, Pa.

Equipment to be shown here will consist of relays, remote control, thermostatic devices, electric melting pots and ladles, and insulating Fish Spine Beads. A thermo-regulator will be shown in operation, which will respond to temperature variations of 1/10 deg., merely placing the hand around the bulb of the regulator causing a relay to operate and light a lamp, which will represent motor load or heating load as the case might be. The equipment can be used for a range from 0 to 300 deg. F. and is compact so that it can be conveniently installed at any point.

Representatives: J. Struthers Dunn, president; J. F. McAllister, secretary and general manager; Norman McKinney, sales manager.

Eastern Refractories Co., Booth 27
10 T. Wharf, Boston, Mass.

Economy Lubricating Co., Booth 448
Charlestown, Mass.

Samples of True-Blue, a successful guaranteed boiler treatment and samples

Representatives: Lewis M. Ellison, Walter T. Ritter, Charles C. Phelps.

Engberg's Electric & Mechanical Works,
Troy, Pa. Booth 15B

Ernst Water Column & Gage Co.,
Newark, N. J. Booth 76

Erie City Iron Works, Booth 93
Erie, Pa.

Electrocon Corp., Booth 610
6 Varick St., New York.

Exhibits here will include the Vibroscope, a stroboscopic device for studying rapidly moving mechanisms, also the Davey Vibrometer for measuring amplitude of vibrations and a portable balancing equipment for balancing rotating machines in service. These instruments will be shown in operation and their accuracy demonstrated. The apparatus will be of interest as showing simply and quickly the location and amount of any vibration so that the high spot of any unbalanced unit may be quickly detected.

Representatives: Stanley D. Livingston, Peter Davey.

Ellison Draft Gage Co., Booth 45
214 West Kinzie St., Chicago, Ill.

Ellison products shown will include 34-pointer draft gage, straight line movement, differential for new Taylor stoker with Venturi nozzle in wind box, one pointer for each nozzle; draft gages with tilted scales; check seal for pointer draft gages to prevent drawing out oil under draft in excess of scale range.

Representatives: Lewis M. Ellison, Walter T. Ritter, Charles C. Phelps.

Fairbanks Co., Booths 232-3
393 Lafayette St., New York, N. Y.

Products to be shown here will include bronze and iron body valves, a main feature of the exhibit being the new Fairbanks Sphero valve, electrically operated.

Representatives: Geo. M. Naylor, president; Jas. A. Cleary, treasurer; E. F. Ryan, factory manager; Edw. T. Adams, mechanical engineer; T. A. Taylor, Jr., manager valve and union division; J. N. Valenzuela, export representative; W. T. Rogers, Geo. R. Sternfield, Gus Schleiser, C. J. Tully, L. Neildenger, J. C. Valentine, R. Kilpatrick.

Federal Gauge Co., Booths 215-6
Chicago, Ill.

Foley Mfg. Co., Booth 451
11 N. E. Main St., Minneapolis, Minn.

Foley Automatic saw filers and grinders will be exhibited and demonstrated, one of the main features being demonstration of filing of hand, band and circular saws by the one filing machine.

Representatives: Walter M. Ringer, president; Willard Johnson, Geo. G. Campbell, Warren P. Tobey, Jr.

Foote Bros. Gear & Machine Co.,
111 N. Canal St., Chicago. Booth 3-F

Speed reducers of antifriction, worm gear and helical gear types will be displayed. The new style antifriction type has a speed ratio of 29 to 1, is equipped with Timken bearings on the worm gear shaft and radial or thrust ball bearings

on the worm shaft. The standard Hygrade type has helical gears on a worm gear shaft for reduction ratios from 50 to 1 up to 100 to 1, the helical gear attachment permitting this reduction at higher efficiency than at a single reduction. The vertical type is of oiltight construction, designed for use in chemical or food plants where oil drip would be objectionable; the ratio is 10 to 1. The Titan helical speed reducer has a ratio of 5.32 to 1, with antifriction bearings on all shafts and hardened helical gears.

Representatives: F. A. Emmons, vice-president; E. A. Phillips, eastern sales manager.

Foster Wheeler Corp., Booths 77, 91
165 Broadway, New York, N. Y.

This space, arranged to face on two aisles, extending through from one to the other, will contain an exhibit of full size sections, models and samples of construction covering air heaters, superheaters, economizers, heat exchangers, pulverized fuel equipment, steam-jet vacuum pumps, expansion joints and water-cooled furnace surfaces. Of particular interest will be the full sized cut-away section of a plate-type air heater, sections of round-tube alloy steel radiant superheaters and pulverized coal equipment. A display board of brass and copper tubing and a complete set of large photographic drawings covering installations of steam generating units, waste heat boilers, muffler boilers, condensers, feedwater heaters, evaporators and associated power plant apparatus will be found of interest.

Representatives: J. H. Bell, Alexander Bradley, P. T. Buckler, H. C. Carleton, D. K. Dean, G. D. Dodd, J. C. Glenn, E. R. Goodrich, J. E. Kenney, H. G. Kitt, F. M. MacDowell, W. L. Martwick, F. G. Page, L. M. Rakestraw, John Sengstaken, D. N. Streeter, F. J. Swenson, T. D. Tyne, G. P. West, H. W. Wetjen, R. H. Wyld.

Foxboro Co., Booths 411-2
Foxboro, Mass.

Indicating, recording and controlling instruments for pressure, temperature and flow of fluids will be exhibited and demonstrated in this space. Special features will be integrating flow meters for pressures of 2500 and 5000 lb. per sq. in., also integrating and recording flow meters for all pressures.

Representatives: C. E. Sullivan, sales manager, C. C. Fuller, New York office manager, in charge; J. B. McMahon, G. E. Clark, R. A. Rockwell, F. J. Leerburger, K. L. Barton.

Fuller Lehigh Co., Booths 54-5
Fullerton, Pa.

This company, a Babcock & Wilcox organization, will exhibit the grinding elements of the new Fuller Lehigh Type B pulverizer. This is an air-separation ball mill which retains all the desirable features of the Lehigh mill including the spherical ball and grinding ring principle in which fineness is unaffected by wear of parts that require lubrication. Also will be shown a large illuminated shadow-box in which will be mounted a cross sectional wash drawing of the pulverizer. To show drawings and photographs of some 50 Fuller Lehigh installations of pulverized coal equipment and Bailey Water-cooled furnace walls, a special displayor will be used giving some interesting facts regarding each of these installations.

Representatives: E. G. Bailey, president, E. J. Billings, vice-president, H. B. Jones, manager, New York office, R. A. Hawk, in charge.

Fulton-Sylphon Co., Booths 219-20
Knoxville, Tenn.

Heating specialties, including damper regulators, stop valves and automatic radiator valves, automatic temperature control for liquids, oil and gases, automatic control for refrigerating systems, packless expansion joints for heating risers and regulators for pressure and vacuum will be included in this exhibit. A new feature is the No. 855 automatic radiator valve which eliminates hand operation of the individual radiator valve and can be set to control accurately the temperature in each room; this is suitable for any two-pipe steam heating system, using floor or ceiling radiators, where pressure is 10 lb. or less.

Representatives: A. W. King, A. W. Shepherd, G. M. Ellis, R. L. Nelson, R. M. Graff, C. F. Jacobs, R Thoma.

R. Y. Furner Co., Booths 402-3
Investment Bldg., Washington, D. C.

G & G Atlas Systems, Inc., Booths 86-7-8
537 W. Broadway, New York, N. Y.

Garlock Packing Co., Booths 545-6
Palmyra, N. Y.

A complete line of fibrous, metallic and semi-metallic packings will be shown, including gaskets, pump valves, valve discs and molded mechanical goods. New products to be displayed will include Garlock 430 Chevron packing, an automatic packing for use against the most severe hydraulic service conditions, and 530 Chevron packing for service against high temperatures. Another new product will be the Garlock 616 button hole tape which is an asbestos gasketing material of new construction to insure a quick and economical joint.

Representative: P. D. Miller, New York district manager.

General Electric Co., Booths 4-5
Schenectady, N. Y.

New, small, mechanical-drive, noncondensing steam turbine for driving pumps, fans and similar equipment will be featured. This is a single-stage with two rows of buckets, casing split horizontally and pipes connected to lower half. Centrifugal governor has weights pivoted on knife edges. Other equipment includes electric gage; outdoor switch house with closing feeder and oil circuit-breaker; 3-section circular type miniature switchboard; induction and synchronous motors; control switches and panels; colorama lighting set controlled by vacuum tubes for varying lighting effects on room walls.

Representative: W. A. Gluesing, in charge.

General Electric Vapor Lamp Co.,
Hoboken, N. J. Booth 4

General Fire Extinguisher Co., Booth 309
420 Lexington Ave., New York, N. Y.

General Insulating & Mfg. Co.,
Alexandria, Ind. Booths 465-6

Products to be shown here will include the Gimco Rock Wool Flexfelt, Rock Wool pipe covering, Rock Wool cork, Rock Wool house insulation and Rock Wool acoustic insulation. New products found in the display will be the No. 320 Monolithic cement, Rock Wool acoustic cement and Rock Wool Homefelt.

Representative: William C. Hyatt, New York.

Gillis and Geoghegan, Inc., Booths 86-8
537 W. Broadway, New York, N. Y.

Girtanner Engineering Corp., Booth 205
Palmyra, N. J.

This company will exhibit special features of ash handling equipment, new style dust collectors and general engineering data with photographs.

Representatives: Alex. Girtanner; E. F. Thum, president, J. J. McNulta, in charge.

Gits Brothers Mfg. Co., Booth 452
1846 Kilbourn Ave., Chicago, Ill.

Products to be shown will include oil seals, oil cups, and lubricators.

Representatives: R. J. Gits, president; Frank Zeman, sales manager.

J. L. Gleason & Co., Booth 618
207 Bent St., Cambridge, Mass.

James T. Gordon Co., Booth 20
11 Park Place, New York, N. Y.

In this booth will be shown an exhibit of the Cleveland Worm and Gear Co., covering its general line of worm gear speed reducers. This will include a type A gear with the upper half removed to show internal construction, also an exhibit showing various sizes of worms. Products of the Andale Co. will also be shown including a self-cleaning continuous

Rotrex Strainer, duplex and simplex basket strainers, an oil cooler and oil heater.

Representatives: James T. Gordon, C. W. Dietrich, Jr., Edwin A. Leibman, New York; Howard Dingle, president and F. E. Bardorf, sales manager, Cleveland Worm and Gear Co.; D. Raymond McNeal, president, and James M. Jenkins, vice-president, Andale Co.

Green Fuel Economizer Co., Booth 73
Beacon, N. Y.

The products shown here will be forced and induced draft fans, air preheaters and the Green Cindertrap. The Cindertrap is for collecting cinders from flue gases. Air heaters are of tubular type for power or industrial plants, and the draft fans are for usual purposes in plant operation.

Representatives: J. M. Birkenstock, in charge; F. K. Howell, C. S. Messler, A. D. Keables, G. W. Aldrich, A. W. Knight, from Beacon; F. R. Brinckerhoff, W. F. Wurster, New York; R. T. Forbes, R. V. Wood, Boston; J. L. Henderson, Pittsburgh; R. N. Turner, Chicago.

This company will exhibit specimens of first and second quality fireclay brick from various manufacturing districts, also high alumina brick which are coming into favor for power plant boiler settings. Samples will be shown of magnesite, chrome, Metalkase, Duro Acid-Proof brick, also Thermolith and Firebond high temperature cements and samples of raw materials for various types of refractories. A special feature will be the projection of a motion picture film of five reels, two reels showing production of fireclay refractories, two covering the manufacture of silica, magnesite and chrome refractories, and the fifth reel showing scenes in the control and research laboratories.

Representatives: W. B. Coullie, sales manager, J. Spotts McDowell, director of research; E. B. Guenther, advertising manager, J. R. Robinson, district sales manager, S. P. Howze, E. S. Stockslager, P. B. Richardson, J. W. Vanderpool, sales representatives.

Hartzell Propeller Fan Co., Booth 211
Piqua, Ohio.

Representatives: A. F. Werner, W. M. Scott, F. K. Stone.

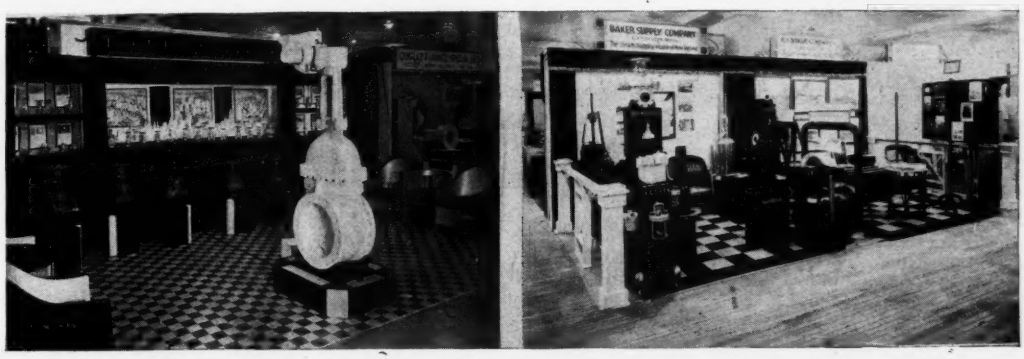
Paul B. Huyette Co., Booths 81-2
5 S. 18th St., Philadelphia, Pa.

PBH products will be displayed here including water gages, gage cocks, inclined water gage adapter, Tiltview water gages, and gage glass protectors. There will also be shown Hays instruments including CO_2 recorders, pointer draft gages, flue gas analyzers and a boiler panel. Other features will be the Cochrane flow meter and Reliance safety water columns. All will be clearly demonstrated by detailed parts with cut sections to show construction and operation.

Representatives: P. B. Huyette, president; Walter C. Edge, vice-president; P. Wood, secretary; Andrew F. Bittner, New York manager, in charge of booth; Walter Molokie, Henry R. Blessing, John F. Larkin, Sam Worley, S. L. Huyette.

Illinois Engineering Co., Booths 83-4
Racine Ave. and 21st St., Chicago, Ill.

This company will exhibit its line of



Greenfield Tap & Die Corp., Booth 461
Greenfield, Mass.

Grinnell Co., Inc., Booths 308-11
Providence, R. I.

Specimens will be shown of pipe bending and welding, the Grinnell Thermolier unit heater for factory and industrial use, pipe hangers, fittings, and a special line of piping for heavy pressure work. Specially featured will be the Grinnell Unit Cooler, a newly developed device for refrigeration work which can be used either with direct expansion ammonia, brine, or other refrigerating systems.

Representatives: J. D. Pryor, vice-president; A. W. Moulder, sales manager; Howard E. Branch, publicity and sales promotion; C. H. Breidenthal, K. W. Haupt, Russell Bontecou, George W. Day, Providence; E. J. Morris, New York; H. P. Conway, Charlotte, N. C.

Griscom-Russell Co., Booth 44-A
285 Madison Ave., New York, N. Y.

Hammar Co., Inc., Booth 603
17 State St., New York, N. Y.

This exhibit will feature Hammar tooth forms for spur, helical and herringbone gearing and will show comparative sizes of gears using these tooth forms as against the old time standards. A comparator will show on the screen a comparison of the action of the different tooth types of gears.

Representative: Charles J. Christesen, sales manager.

Harbison-Walker Refractories Co.,
Farmers Bank Bldg., Pittsburgh, Pa.
Booth 58

Hazard Insulated Wire Works, Booth 619
Pittsburgh, Pa.

Heat Transfer Products, Inc.,
30 Church St., New York, N. Y.
Booths 338-9

Large size photographs will be displayed of the H.T.P. equipment showing its application and installation, and literature will be provided describing details of construction and operation.

Representatives: Geo. T. Jacocks, president; Robert I. Hicks, II, sales manager; Stanley J. Chute, chief engineer; Murray O. Smyth, advertising department; John C. Mahoney, Claude F. Tears, Roman P. Kanski, Cuyler S. Patton.

Hedges-Walsh-Weidner Co., Booth 25
Chattanooga, Tenn.

Heine Boiler Co., Booth 24
St. Louis, Mo.

Hisey Wolf Machine Co., Booths 340-1
Cincinnati, Ohio.

E. F. Houghton & Co., Booths 532-4
240 W. Somerset St., No. Philadelphia, Pa.

Howell Electric Motors Co., Booth 441
Howell, Mich.

Here will be shown standard squirrel-cage polyphase motor, vertical squirrel-cage polyphase motor, fully-enclosed, fan-cooled polyphase motor, condenser-type, single-phase motors of standard type and for farm duty. A special feature will be a single-phase, condenser-type motor for elimination of complications in the construction and operation.

radiator valves, radiator traps, blast traps and steam specialties, displaying cut sections in a brilliantly illuminated shadow box as one item. Another item will be a completely piped set-up of the company's vapor system as to boiler room equipment, showing boiler return trap and heat radiator in cut section as connected for service. A glass working model of the company's Eclipse steam trap under steam will be shown illustrating the operation of the valve mechanism. A special feature will be a model showing three of the company's full sized electrically operated Zone Control valves for heating systems, with panel board connected to current showing the operation of the board with its telltale lights and operation of the valves.

Representatives: James C. Matchett, vice-president; J. L. Ehretsman, in charge; A. L. Browne, New York; A. F. Nesbet, Chicago; A. Bittner, New York, representative on high pressure equipment.

Imperial Coal Corp., Booth 36
295 Madison Ave., New York, N. Y.

High grade, high and low-volatile industrial steam coals will be exhibited. A new process will be the Calcium Chloride treatment of coal at the mine to eliminate dust at plants where that is a serious objection.

Representatives: George E. Owen, Howard J. Roberts.

Industrial Controller Co., Booth 442
Milwaukee, Wis.

Instant Water Heater Sales Div.,
332 S. Michigan Ave., Chicago, Ill.
Booth 273

Cut out sectional view of a typical heater will be shown to demonstrate the arrangement of two interior copper pipes which comprise the heating element. In addition there will be exhibited a complete heater of medium size, also the Instant flow control and photographs of typical installations and blueprint layouts.

Representative: H. B. Fridstein, sales manager.

International Nickel Co., Inc., Booth 9
67 Wall St., New York, N. Y.

Monel metal and pure nickel will be shown in commercial forms, rods, sheets, wire, forgings, castings; also finished parts of power plant equipment as used by leading manufacturers.

Representative: F. V. Lindsey, Jr.

Iron Fireman of N. Y., Inc., Booths 291-2
151 E. 128th St., New York, N. Y.

Two stokers, one for power use in large office buildings, hospitals and the like, the other a small unit for home owners, will be displayed.

Representative: Mr. Farrell, sales manager.

Irving Iron Works Co., Booths 439-40
3rd Creek St. & Dutchkills Creek, Long Island City, N. Y.

I-T-E. Circuit Breaker Co., Booths 624-5
19th and Hamilton Sts., Philadelphia, Pa.

In this exhibit the new feature will be a two panel I-T-E Multumite switchboard, a self-supporting all steel clad unit consisting of two panels mounting the company's type senior W and LX hand and remote controlled air circuit breakers. Each breaker will be completely wired and the remote control devices connected for demonstration as to closing and tripping. There will also be on display type LG hand operated air circuit breakers up to 2000 amperes capacity, and type LX from 200 to 1250 amperes. Several smaller Junior and Senior Auto-U-Re-Lites, standard air circuit breakers totally enclosed in steel boxes with suitable barriers and manual operating handle attached to the box, will be shown. A special feature will be waterproof Senior Auto U-Re-Lites, suitable for service in oil fields, mines and other locations where explosion proof apparatus is desirable.

Representatives: W. C. Jessup, R. C. Heyl, M. B. Cutting, T. J. Ashe, Jr.

Janette Mfg. Co., Booth 538
556 W. Monroe St., Chicago, Ill.

Jarecki Manufacturing Co., Booths 518-9
Erie, Pa.

This company will display its lighter products including iron and brass valves, malleable, cast-iron and brass pipe fittings, and pipe-threading machines. Special demonstration will be made of new heavy-duty, high-speed pipe threading machine with automatic self-opening die head and Timken roller bearings, the 8-in. machine giving an average threading speed of over 29 ft. per min. and cutting off 8-in. pipe at over 100 ft. a min. The automatic opening of dies, rapid adjustment for die head and high spindle speed are features contributing to rapid action.

Representative: Carl A. Jarecki, treasurer.

Johns-Manville Corp., Booth 14
292 Madison Ave., New York, N. Y.

Kaye and MacDonald, Inc., Booth 212
94 Franklin Ave., West Orange, N. J.

This company will exhibit its K-Master inverted-bucket steam trap in operation, the K. & M. safety steam trap in operation with the cover removed, the K-Master inverted-bucket steam trap with a water logging float. Cutaway model will demonstrate the construction of the inverted-bucket steam trap, the safety steam trap and the Master float trap, as well as making clear the operation of the various types.

Representatives: James W. Kaye, president; H. D. MacDonald, secretary and treasurer; E. L. Orndorff, Eastern Central states sales manager; Perry M. Moore, Metropolitan representative; Joseph Breckley, New Jersey representative.

Keasbey & Mattison Co., Booth 3E
Ambler, Pa.

E. F. Keating Pipe Bending Co.,
452 Water St., New York, N. Y.
Booths 229-30

Reinforced square corner Van Stone Flanged Joints made from genuine wrought iron, lap welded steel, seamless steel, Toncan and brass pipe; also large bends, welded headers, pipe coils, high-pressure piping, boiler tubes and valves will be displayed.

Representative: Maurice Readey, secretary.

Keller Mechanical Engineering Corp.,
Booths 645-6
70 Washington St., Brooklyn, N. Y.

M. W. Kellogg Co., Booth 31
225 Broadway, New York, N. Y.

This exhibit will feature exclusively the vessels manufactured by the company's newly developed electric fusion welding proces, showing vessels tested to destruction and the results of many tests on the materials and welds. The application of electric fusion welding process to the general line of pressure vessels will be demonstrated.

Representative: H. S. Newlin, engineer, pressure vessel division.

Kelly Co., Booth 274
372 W. Grand Ave., Chicago, Ill.

Kennedy-Van Saun Mfg. & Engr. Corp.,
2 Park Ave., New York, N. Y. Booth 30

Main features of this exhibit will be a scene-in-action machine, which will show the actual operation of a Kennedy Air-Swept tube mill firing a boiler and the same type of machine, showing a gyratory crusher in action, also many photo-posters showing plant installations will be displayed.

Representatives: J. E. Kennedy, president; R. M. Kennedy, secretary; F. O. Reedy, vice-president; A. W. Hamilton, treasurer; H. W. Johnson, chief engineer; A. D. Hesse, chief draftsman; J. V. Pyle, assistant sales manager; C. J. Jefferson, mechanical engineer; A. Gruenwald, erecting engineer; O. H. Ruiz, A. J. Kutchera, C. B. English, sales engineers.

Keuffel & Esser Co., Booth 612
Hoboken, N. J.

Keystone Lubricating Co., Booth 3
21st & Lippincott Sts., Philadelphia, Pa.

Keystone greases, grease cups, safety lubricators, Pneuma-Lectric automatic lubricating system and a demonstration of various hook-ups and methods of applying this system, will be shown.

Representatives: H. A. Buzby, president; A. T. Lowry, New York district manager; L. A. Webster, Boston district manager; C. O. Norstrum, special representative; H. M. Ludwick, mechanical engineer; L. R. Humpton, electrical engineer; F. D. Street, sales engineer; R. L. Martin, Philadelphia; L. Englander, W. J. Robinson, New York.

Keystone Refractories Co., Booth 11
120 Liberty St., New York, N. Y.

This company will have on display Dura-Stix firebrick cement, Steel-Veneer Key-Frax and Crundumsand granular refractories, and Plastobrix firebrick. Special demonstrations will be made of the application of these various products to modern furnace practice.

Representatives: Frederick W. Reisman, president and general manager, in charge; L. E. Turk, secretary and treasurer; B. G. Pitcher, F. M. Leach, P. Murphy, J. G. Collier.

Walter Kidde & Co., Inc., Booth 293
140 Cedar St., New York, N. Y.

This company will exhibit Lux and Fyre-Freez portable carbon dioxide type fire extinguishers and will demonstrate their effectiveness in combating fire danger.

Representative: P. W. Eberhardt, in charge.

Kieley & Mueller, Inc., Booths 281-2
34 W. 13th St., New York, N. Y.

Products to be shown in this display will consist of pressure reducing valves, steam straps, float valves, liquid level controllers.

Representative: C. H. Dutcher, manager, in charge.

Kilsoot Carbocide Co., Inc., Booth 449
1834 Broadway, New York, N. Y.

Exhibit will be made of Kilsoot and Carbocide for removal of soot and carbon scale from boiler surfaces on the firesides.

Representatives: E. L. Geldert, president; I. B. Stafford, supervising engineer; W. J. Perreault.

Kissick-Fenno Co., Inc., Booth 19
15 Park Place, New York, N. Y.

"Klingerit" Inc., Booth 317
16 Hudson St., New York, N. Y.

Klingerit products including asbestos sheet packing and gaskets, Two-color stuffingbox packing, piston valves and valve discs will be displayed here, also the Reflex and Through-Vision oil and water gages.

Representative: Herman Strahman, treasurer.

J. M. Kohlmeier, Inc., Booths 520-1
Long Island City, N. Y.

Korfund Co., Inc., Booth 15B
235 E. 42nd St., New York, N. Y.

Products to be included in this exhibit will be Korfund plates, natural cork plates for the isolation of engine foundations; Vibro-Dampers, an adjustable spring device for elimination of vibration from machines operating with heavy sudden impact, excessive humming noises and high rotative speeds; Absorbit, a soundproofing material for walls; Absorbophone, a soundproofing material for floors.

Representatives: S. Rosenzweig, president; H. E. Wall, sales manager.

The Kraissl Co., Booth 430
23 East 26th St., New York, N. Y.

Pumps and strainers of various types, including centrifugal, rotary, fuel oil, internal gear, vacuum and possibly steam pumps will be exhibited. Two main features will be a panel showing working demonstrations of the various types of displacing mechanisms as used in the company's pumps, mounted so that they can be operated to show clearly the action. Another feature will be demonstration of a fuel oil duplex pump set completely mounted.

Representative: F. Kraissl, Jr.

LaBour Co., Booth 32
Elkhart, Ind.

Self-priming centrifugal pumps, showing both stationary electrical driven pump as well as the portable gasoline-engine-driven outfit will be shown. One pump will be operating to demonstrate its ability to handle air and prime itself. A new product which will be featured is the automatic suction control valve for use where one pump is connected to several sumps while the function of the valve is to automatically open and control the water level in each sump, thus eliminating the necessity for a separate pump for each sump. The valve can also control water levels in the various sumps regardless of the elevation of the pits.

Representatives: N. A. Pedersen, Elkhart; John H. Barker, H. A. Lester, C. Haitsma, G. C. Moore, eastern representatives.

Ladd Water Tube Boiler Co., Booth 23
Pittsburgh, Pa.

Lead Lined Iron Pipe Co., Booth 11
Wakefield, Mass.

Products shown will include Wakefield amalgamated lead-lined and tin-lined, lead-covered and tin-covered, lead-dipped and tin-dipped pipe, fittings, valves, tubes, pumps and special apparatus for hot and cold water service, for handling acid and other corrosive liquors and for special use on carbonated and distilled water and fruit juices.

Representatives: Thomas E. Dwyer, president, in charge; John D. Dwyer, secretary; D. F. Dwyer, manager; John J. McGurty, assistant to the manager.

Leavitt Machine Co., Booth 255
Orange, Mass.

Complete line of Dexter valve reseating machines will be demonstrated and details displayed at this booth. Operation of the machines for globe valves, gate valves and pump valve seats will be demonstrated.

Representatives: E. S. Hersey, sales engineer; C. C. Phelps, New York; William A. Harris, New England; James A. Stuard, Pennsylvania.

Leeds & Northrup Co., Booth 18
4901 Stenton Ave., Philadelphia, Pa.

Principal features of the equipment exhibited here will be metered combustion control, automatic frequency control, percent leakage recorder for measuring condenser leakage, smoke recorder, speed recorder, Mueller thermometer bridge, semi-precision potentiometer, platinum resistance thermometers and thermocouples.

Representatives: L. O. Heath, R. Cleeland, S. B. Morehouse, H. L. Scutt, B. F. Keene, R. A. Mason.

Leslie Co., Booths 556-7
Lyndhurst, N. J.

Emphasis will be placed in this exhibit on the new Leslie pump regulators and new type reducing valves in both steel and bronze. The complete line covers pressure regulators, reducing valves, pump pressure regulators, excess pressure regulators, self-cleaning strainers, bronze castings, and engineering specialties. In these specialties no stuffing boxes are used and the wearing and working parts are renewable, of stainless steel, nickel alloy and high pressure bronze.

Representatives: S. I. Leslie, president; J. J. Cizek, vice-president; F. J. Thrush, J. M. Naab, S. Soderberg, R. Courter, F. D. Riggio, D. Lytte, A. F. Braghetta.

Limitorque Corp., Booth 16
Williamstown, Mass.

This company will exhibit an electrically-operated Limitorque valve control, cut away to show actual operation; also a display board showing all parts of the Limitorque control.

Representatives: Payne Dean, president; W. W. Clinedinst, sales manager; Joseph McKay, salesman.

Linde Air Products Co., Booths 334-5
30 E. 42nd St., New York, N. Y.

In this exhibit the theme will be the variety and dependability of products fabricated by oxy-acetylene welding, special emphasis being placed on this method of welding for installation of power piping and in the construction of pressure vessels. Exhibits will be seen of complicated headers, fabricated by oxwelding, and of pressure vessel joints. A large map will show distribution facilities of this and affiliated companies. The Oxweld Type W-17 Welding blowpipe and cutting attachment will be displayed.

Representatives: J. J. Payden, H. H. Griffith, T. G. Schwartz.

Link-Belt Co., Booths 285-7
910 S. Michigan Ave., Chicago, Ill.

This company will display silent chain drives, roller chain drives, speed reducers and a new product, P.I.V. Gear, which will be announced at the show. In addition there will be a model of a rotary railroad car dumper as installed at the State Line generating plant, the Waukegan generating plant and other power plants. Literature descriptive of the company's products and photographs showing interesting installations will form a part of the exhibit.

Representatives: Harry D. Mitchell, A. J. Drew.

Liquidometer Corp., Booths 487-8
Skillman Ave. at 37th St., Long Island City, N. Y.

McAvoy Products Co., Booth 525
19 W. Jackson Blvd., Chicago, Ill.

Manistee Iron Works Co., Booth 48
Manistee, Mich.

Marburg Brothers, Inc. Booth 427
90 West St., New York, N. Y.

Thiel precision die filing and sawing machines will be exhibited and demonstrated. To take the place of drilling, chipping and filing in making dies, jigs, punches, cams, templates, and the like. Details of the device are automatic feed, a tilting table, adjustable stroke and magazine feed of saws.

Representatives: Theodore H. Marburg, president; Louis C. Marburg, secretary and treasurer; Richard Krause, F. Wenzel.

James P. Marsh & Co., Booths 258-59
2073 Southport Ave., Chicago, Ill.

Mason Regulator Co., Booth 218
Dorchester Center, Boston, Mass.

Mercoid Corp., Booths 215-6
25 Church St., New York, N. Y.

Mercoid controls and kindred devices for the automatic electric regulation of temperatures, pressures, liquid levels and mechanical applications will be exhibited. Features of the display will be newly designed Mercoid Control Instruments for heating and refrigeration industries and a constant current transformer and incandescent ignition system for oil burner control.

Representatives: L. H. Van Ness, president; N. J. Allaben, executive vice president; I. E. McCabe, chief engineer; A. N. Schultz, electrical engineer; A. W. Barr, Canadian sales engineer; W. K. Stauffer, sales engineer; C. A. Bier, sales representative.

Merrick Scale Mfg. Co. Booths 237-40
Passaic, N. J.

Midwest Piping & Supply Co., Inc.,
St. Louis, Mo. Booths 221-2

New modifications of Van Stone joints, including the Globack and Midwest will be exhibited. There will also be a dis-

play of modern welding, as well as pulled test specimens of welding and Van Stone joints, forged and hammer welded flanges and wrought iron and brass Van Stone pieces.

Representatives: Ivan S. Forde, eastern sales manager; H. F. Urbauer, A. G. Stoughton, W. Siegerist, E. A. Kerbey, A. H. Dirk.

Millers Falls Co., Booth 431
Millers Falls, Mass.

Portable electric drills, screwdrivers, hammers, sanders, and portable grinders will be found here. Powerful drills and grinders will be featured.

Representatives: G. U. Hatch, vice-president; F. H. Barter, sales promotion manager; Roger L. Bracken, district manager; J. J. Coleman, C. M. Heath, S. C. Judy, R. B. Brush, J. T. Williams.

Moto Meter Gauge & Equipment Corp., Booths 622-3
449 Hamilton St., Toledo, O.

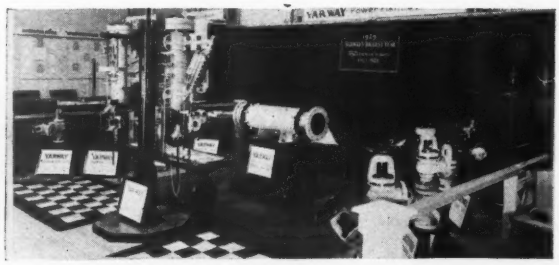
Motoco dial indicating distance reading industrial thermometers, recording thermometers, pressure gages, Oxy-acetylene gages, bakelite parts, lithographed and etched products will be exhibited.

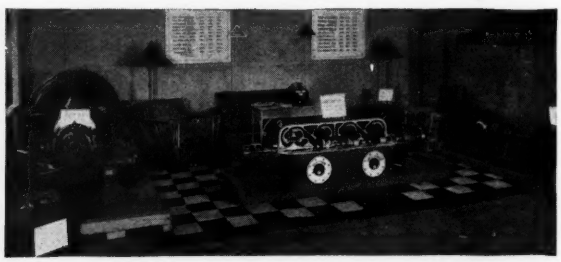
Representatives: R. G. Martin, president; C. M. Adams, vice-president; Walter V. Flood, secretary; Alfred Weiss, manager, industrial division; Joseph Halla, J. E. Gamache, R. E. Bruckner, R. R. Hopkins, J. A. O'Connor.

Multi-Valve Corp., Booth 289
New London, Conn.

Lee Multi-Stage valves, a new product placed on the market during the past year will be exhibited. This is a specialty for stop, drain, blowoff, throttling and general service for pressures up to 600 lb. with a special form of multiple contact between the valve and seat.

Representatives: H. B. Lee, L. A. Ward.





Minneapolis-Honeywell Regulator Co.,
Minneapolis, Minn. Booths 235-6

Motor-operated valves and controlling devices for space heating and industrial processes will be shown.

Representatives: G. D. Kingsland, manager space heating division; R. L. Goetzenberger, manager industrial regulator division; A. P. Mudgett, New York manager; J. E. Haines, J. T. Midyette, sales engineers, New York; A. Michelson, Philadelphia manager; L. H. Plum, sales engineer, Philadelphia; W. F. Arnoldy, Boston manager; J. Turner, sales engineer, Boston; Curtis Delano, Washington, D. C.

Mixing Equipment Co., Inc.,
1024 Garson Ave., Rochester, N. Y.
Booths 279-80

Models of "Lightnin" portable mixers, also Side angular-propeller-type agitators for tanks of any size will make up the exhibit in this booth.

Representatives: F. L. Craddock, president, in charge; D. R. McKillican, C. F. Donovan.

Morse Chain Co., Booths 267-8
Ithaca, N. Y.

This year the company will demonstrate Morse Silent Chain drive, flexible couplings, structural steel chain speed reducer, disc and ring oilers. True rocker action of the chain will be shown by an improved device so that the observer can easily study the joint action while the chain is in operation. Speed reducers and flexible couplings will also be operated to show the provision for end thrust and misalignment. The ring oiler for chains will be operated under glass to illustrate its action.

Representatives: A. B. Wray, sales manager; F. G. Anderson, promotion engineer; W. W. Bertram, New York manager, in charge; C. C. Crandall, New York.

Nash Engineering Co., Booths 53, 66
So. Norwalk, Conn.

Nathan Manufacturing Co., Booths 530-1
250 Park Ave., New York, N. Y.

Miscellaneous mechanical lubricators for stationary engines and locomotives will be shown, also Nathan automatic oil feeders for bearings and brass and bronze castings. Demonstrations will be made of lubrication of various bearings and other parts to be lubricated, also loose pulleys equipped with automatic oil feeders. With these lubricators a separate piston is provided for each feed with no valves used; a partial turning of piston at highest and lowest points opens ports which function as suction and delivery valves. Ratchet or rotary position feed is provided, each feed being separately adjustable.

Representative: M. H. Potter, in charge.

National Co., Booth 76
Malden, Mass.

National Tube Co., Booths 535-7
Frick Bldg., Pittsburgh, Pa.

Neemes Foundry, Inc., Booth 56
206 First St., Troy, N. Y.

This company will exhibit full size operating models of its Superior dumping grate, its Improved shaking and dumping grate and its Automatic stoker. Each of the exhibits will be so mounted that the entire mechanism will be accessible for examination. The dumping and shaking grates will show a recently developed type of mechanism designed for simplicity and compactness. The dumping grate will be so arranged that it can be operated by interested spectators to demonstrate the ease of operation and how uniformly the dumping sections align themselves when dropped back to normal position. This section will also demonstrate the detachable lugs which is a simple method of changing from right to left-hand section. For the shaking grate, the visitor will also be able to operate the exhibit to illustrate the manner of agitation of the fuel bed and the size of the openings which are formed in the dumping position. The automatic stoker will have grate surface of 6 by 6 ft., will be fully operative and will have an uptake damper connected with the automatic damper control feature to demonstrate operation. Recent improvements in the stoker include simplification and compacting of damper control; compacting of gear reduction and motor unit; simplification of the coal feed adjustment; increase of the ranges of the adjustment available for coal progression; improvement in the manner of breaking up the coke bed; new design, to permit removal of the entire combustion surface mechanism as a unit for inspection or repair and of parts of the coal feeding mechanism for strength and durability.

Representatives: R. R. Rees, E. C. Welsh, A. B. Taylor, O. J. Vashrow, D. A. Campbell, R. E. Page.

New York & Richmond Gas Co.,
691 Bay St., Stapleton, N. Y. Booth 7

W. H. Nicholson, Booth 20
Wilkes-Barre, Pa.

Norma-Hoffman Bearings Corp.,
Stamford, Conn. Booths 263-4

This company will display a complete range of sample ball, roller and thrust bearings, illustrating the Hirth minimeter and a number of industrial units in which the bearings are used, sectioned to illustrate the mounting of the bearings. For the first time double-row, self-aligning and angular contact ball bearings will be displayed, also the new GreaSeal felt protected ball bearings.

Representatives: H. J. Ritter, assistant secretary; D. E. Batesole, assistant engineering manager; F. W. Mesinger, New York District manager, in charge.

North Electric Mfg. Co., Booth 417
Galion, Ohio.

As the main feature of this display will be an All-Relay type of automatic telephone system. In addition will be exhibited remote power control equipment and automatic stock quotation equipment.

Representative: J. W. Concagh, New York district manager.

Northern Equipment Co. Booth 19
Erie, Pa.

Featured in this display will be a

demonstration and explanation of an excess pressure control in the boiler feed line. An exhibit board will demonstrate the whys and hows of differential water pressure regulation as used in modern power plants. Copes feedwater regulator and Copes differential water pressure regulating valve will be shown installed in the feed line to a typical boiler. Equipment will be full size and cutaway so that operation can be readily seen, while meters will show load and water flow and a continuous chart will give pump pressure, regulator inlet pressure and boiler pressure, reproducing the action of the equipment under conditions of changing boiler loads. A Copes Valve Movement indicator will show how the regulator valve opens and closes in accordance with changes in boiler water level. Another feature will be the Copes RG valve for combining the flow control valve with the excess pressure control valve in a single compact body; the Copes pump governor and Copes type CRI valve for high-pressure condensate drainage control will also be exhibited.

Representatives: E. W. Nick, president; V. V. Veenschoten, C. E. Wolff, Jr., K. B. Whitley, Don Allshouse.

Norton Co., Booth 10
Worcester, Mass.

Alundum bricks, Crystolon bricks, refractory cements, electrically fused magnesia products, linings for enameling furnaces, for ceramic kilns and for steel-treating furnaces, tubes, cores and muffles will make up the exhibit in this booth. The company will also show Alundum and Crystolon grinding wheels.

Representatives: R. Kirkpatrick, sales manager, refractories division; F. H. Stenberg, publicity department; F. E. Leiby, refractories division, in charge; R. J. Gillander, W. H. Henson, refractories division.

Wm. W. Nugent & Co., Inc., Booth 400
410 N. Hermitage Ave., Chicago, Ill.

Working models will be shown of gravity and pressure types of oil filters and pumps; also full size equipment in sight feed valves and flow indicators, telescopic and multiple oilers, compression union threadless pipe fittings, oil pumps, level gages and filters, crank pin oilers. Full details of each device and method of operation will be displayed.

Representatives: Wm. W. Nugent, Corliss D. Nugent, John Vocelka.

Nye Tool & Machine Works, Booth 641
4120 Fullerton Ave., Chicago, Ill.

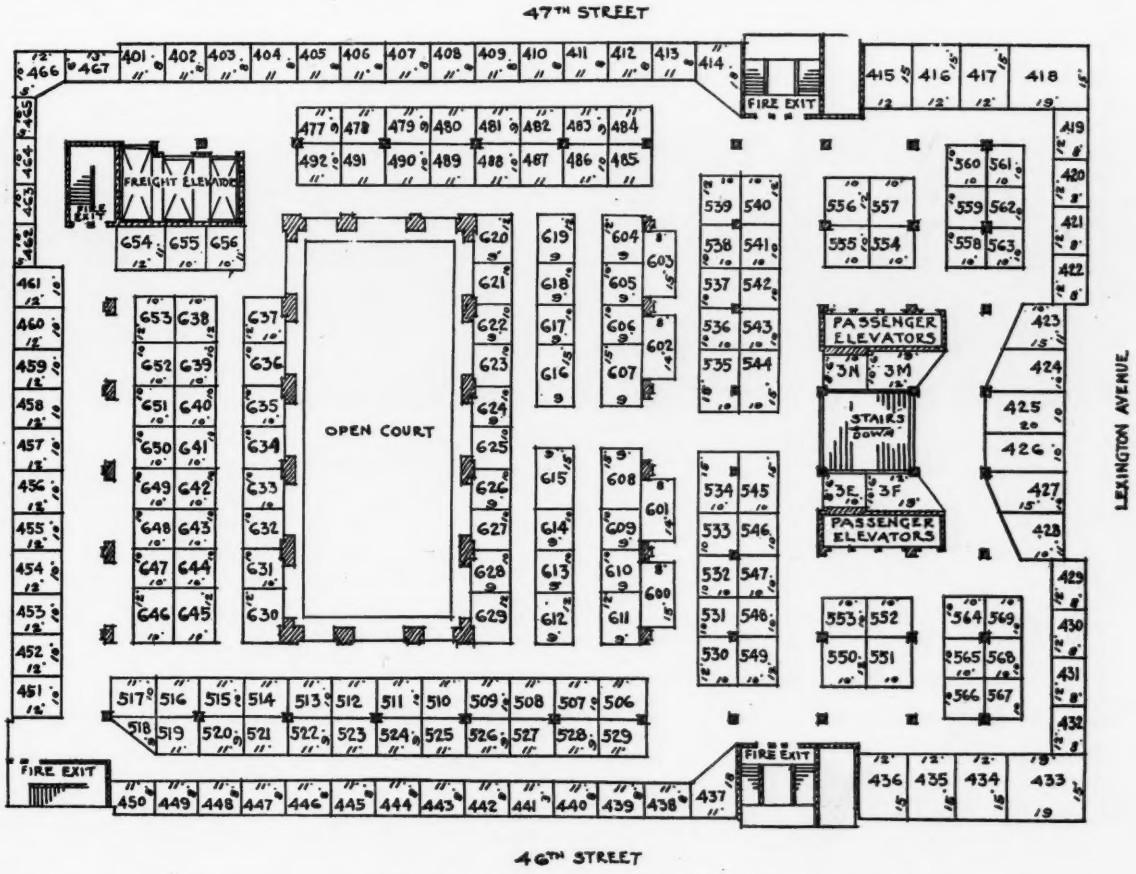
Lightweight Champion pipe threading and cutting machines will be shown for pipes from ½ up to 2 in. and for threading, cutting off and reaming pipes; also a display of hand-threading and cutting tools mounted on a special display board.

Representatives: Harry Olsen, New York; Russell Forster, Philadelphia; T. M. Lilleberg, Chicago.

Oakite Products, Inc., Booth 257
22 Thames St., New York, N. Y.

Methods for cleaning apparatus in power plants such as oil coolers, surface condensers, generators, transformers, high-tension insulators, boiler fronts and lighting equipment, also the cleaning of equipment in machine shops will be shown here. Model operating equipment and comparison specimens will be utilized to illustrate development of the Oakite field service.

Representatives: H. L. Gray, D. A. Hearn, G. Seib, J. A. Carter, E. Lingle, A. A. Kopp, S. A. Wood, L. B. Johnson, C. Johnson, Mr. Geh, V. D. Smith, W. Flynn.



PLAN OF THIRD FLOOR, BOOTHS 401 TO 656

S. Obermayer Co., Booth 27
2563 W. 18th St., Chicago, Ill.

Products shown here will be Ramtite plastic monolithic furnace lining, Hot Patch patented high temperature cement and various refactory specialties. A special feature of the exhibit will be the illustration of the adaptability of the furnace lining to various types of special furnace construction.

Representatives: Theodore Kauffman, Jr., manager, refractory division; Harold E. Beckman, E. D. Frohman, R. H. Ward, G. Quint, J. C. Pape.

Okonite Co., Booth 619
501 Fifth Ave., New York, N. Y.

At this booth wires and cables with Okonite and varnished cambric insulation will be shown with cutback sections

to display the various kinds of construction employed for various uses of these cables for electrical power purposes. Okonite-Callender impregnated paper insulated cables for high-tension power transmission will be shown, also Hazard wires and cables. Comparative tests on rubber sheathed cords and cables will show the method of testing Okocord for abrasion, kinking, yanking and impact.

Representatives: Robert M. Johnson, in charge; Charles Neudoerffer, John M. Bellavigna, Walter W. Fleming; George W. Clinchy, R. H. Osgood, Hazard Insulated Wire Works, division.

Okonite-Callendar Cable Co. Inc., Paterson, N. J. Booth 619

Tinius Olsen Testing Machine Co., 300 N. 12th St., Philadelphia, Pa. Booth 17

Oxweld Acetylene Co., Booth 334
30 E. 42nd St., Philadelphia, Pa.

Permutit Co., Booths 306-7, 348
440 Fourth Ave., New York, N. Y.

Two exhibits will be made, Ranarex CO_2 and Gas Density recorders will be shown in booths 306 and 307, a water softening equipment in booth 348. All Ranarex machines will be shown in operation and details of the records will be demonstrated. In booth 348 will be a 30 in. Permutit water softener, a 12 in. softener and electro chemical feeds in operation, both constant and intermittent types being shown. Literature will describe other power plant and water feeding specialties.

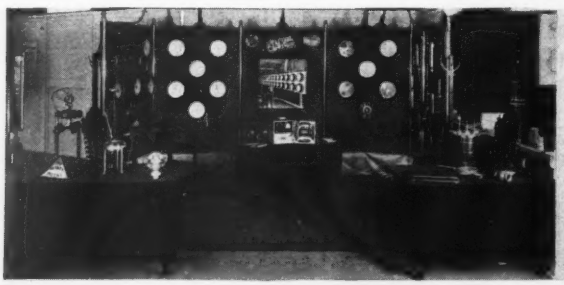
Representatives: Booth 306: Eric Pick, George P. Kaiser, P. A. Nome, W. J. Bay, F. D. Harger. Booth 348: M. F. Corin, manager of sales; L. S. Ferguson, assistant manager of sales; R. W. Epple, J. S. Shedden, E. L. Root, N. D. Doane, W. H. Mitchell, D. J. Hess.

Power Control Corp., Booth 617
Syracuse, N. Y.

Prat-Daniel Corp. Booths 26, 26A
183 Madison Ave., New York, N. Y.

Product to be shown as special feature of this exhibit will include an operating transparent model of a Type II Thermix ejector form of stack used for boosting the draft with high temperature gases yet keeping the fan out of the current of hot gas. Another special feature will be a Thermix Type IV dust collecting fan in operation in an enclosed circuit to display collection of dust by this means. Also there will be exhibited the Type I induced draft form of stack and the Type III ejector form of stack.

Representatives: Louis C. Whiton, Jr., president; H. L. Parry, engineering department, in charge; John E. Watson, C. B. McBride, V. S. Lewis.



O. D. Patents Corp., Booth 462
541 Isham St., New York, N. Y.

Parker Appliance Co., Booths 626-7
10320 Berea Rd., Cleveland, Ohio.

Tube Couplings of standard and triple type, the latter being a new product introduced during the past year to be shown; also a display will be made of production and hand tube-bending equipment, valves, coils, draft meter manifolds and power plant units. Data sheets and descriptive matter will be available at the display.

Representative: A. L. Parker.

Peerless Machine Co., Booth 529
1615 Racine St., Racine, Wis.

Peerless Universal-Type, high-speed metal sawing machines, 6 by 6 and 9 by 9 in. capacity will be shown for production sawing on mild rolled and tool steel. There will also be an exhibit of Universal No. 2 portable pipe cutting and threading machine of ¼ to 2 in. capacity.

Representatives: Charles Rasmussen, president; I. M. Ward, vice-president; R. T. Ingalls, secretary and treasurer.

Henry Pels & Co., Inc., Booth 2
90 West St., New York, N. Y.

Here will be found a size 16 Quadruple-Combination punch, plate-splitting shear, bar, angle and tee cutter, with built-in notcher, and a like machine but of a smaller size. The 16 in. has capacity for plates up to 5/8 in. for splitting, 2⅛ in. rounds and 1⅞ in. squares for cutting and ⅞ in. holes through ¾ in. plate for punching. The 10 in. size has capacity of ⅝ in. plates for splitting, 1½ in. round or 1⅜ in. squares for cutting and ¾ in. holes through ½ in. plate for punching. The shears will be operated by a motor on top of each machine.

Representative: T. F. Kane.

Philadelphia Gear Works, Booth 13
12 W. 41st, New York, N. Y.

Pittsburgh Coal Co., Booths 336-7
Pittsburgh, Pa.

This company will show, by the use of chemicals and coal, the products as received from the ground and the products of its mechanical cleaning plant. There will also be shown a complete and descriptive motion picture telling the story of mining, loading, mechanical cleaning, sizing, loading into railroad cars and distribution; in other words, a story from the time a man enters the mine until coal is out on the main line of the railroad.

Representatives: W. L. Sheppard, general sales manager; R. E. Frazer, New York district manager; E. G. Lidgate, J. W. Brennan, A. E. Dietrich, sales engineers; C. A. Reed, combustion engineer, Pittsburgh; H. N. Smith, combustion engineer, New York.

Plibrico Jointless Firebrick Co., Booth E92
1800 Kingsbury St., Chicago, Ill.

Jointless Plibrico furnace lining will be shown with adaptations as a refractory lining under boiler and industrial furnaces.

Representatives: I. S. Pieters, vice-president; C. A. Werner, New York manager; R. L. Woodward, New York.

Porter-Cable-Hutchinson Corp., Syracuse, N. Y. Booths 630-1

Woodworking machines will be shown and demonstrated, including Take-About sanders, Ever-Ready combination woodworkers; Beaver woodworkers; Speedmatic saws, which are portable, a 16-in. bandsaw and a bench saw.

Representatives: A. B. Paterson, advertising manager; J. G. Well, A. N. Frecker.

Preferred Utilities Co., Booths 303-5
33 W. 60th St., New York, N. Y.

In booths 203-4 Ray burners with controls for domestic, commercial and industrial use will be displayed and many industrial products manufactured in the combustion gases from a Ray Industrial fuel burner will be shown. Hart Domestic oil burners will be displayed in booth 205, mounted on a combination triple service steel boiler with the necessary controls for automatic, hot water installed on the burner and boiler. This combination provides a garbage incinerator and the use of a storage tank for domestic hot water. Specially featured will be a new product, the Ray Combination gas-oil burner, the exhibit showing the method of changing from an oil burning to a gas-oil burning system.

Representatives: J. S. Kaplan, Arthur Roberts, Jack J. Spalding, Jr., B. K. Breed, Henry Downe.

Production Machine Co., Booth 460
Greenfield, Mass.

Quimby Pump Co., Inc. Booths 252-3
340 Thomas St., Newark, N. J.

Quimby high pressure fuel oil pumps and screw pumps for booster service will be exhibited and demonstrated. There will also be shown Quimby Doty Goodrich Vulcalock rubber lined centrifugal pump and corrosion resisting pumps. An 8-stage centrifugal pump will be included in the exhibit, also a small vertical sump pump, a CP Quimby pneumatic sump pump and a Quimby paper stock pump in operation. Of these the rubber lined pump, the pneumatic sump pump and the paper stock pump are new and will be of particular interest, the paper stock pump being shown for the first time and designed to handle heavier paper stock than has heretofore been attempted.

Representative: H. E. Quimby, in charge.

Radiator Specialty Co., Booth 606
Charlotte, N. C.

Rawlplug Co., Inc., Booth 539
98 Lafayette St., New York, N. Y.

Rawlplugs, screw anchors made of jute fibre require holes slightly larger than the screw, so that when the screw enters the plug is tightly compressed against the sides of the hole for the full length, will be exhibited and demonstrated. The Rawldrill for fast cutting in masonry and which can be dressed on the job, will also be shown. Another feature will be the Crowner and Lok-Crowner, a new device for protection of the heads of screws and ornamental finish.

Representative: H. G. Janton, exhibit manager.

W. S. Ray Mfg. Co., Booth 303
San Francisco, Calif.

Reeves Pulley Co., Booths 34-5
Columbus, Ind.

In these booths will be shown the latest design and construction of Reeves variable speed transmissions with several units in operation. New designs of electrical remote and electrical automatic control for these transmissions will be demonstrated, showing the method of operation from one or more push button stations, or entirely automatically. Standard and special designs of horizontal and vertical transmissions will be in operation. Another special feature will be a new compact design, embodying double-block, center-pull V belts with aluminum splice blocks, automatic electric control, solenoid brake on pilot motor and demonstration of the method by which the motor electrical control or automatic control can be attached to older installations.

Representatives: G. L. Reeves, president; R. F. Reeves, secretary and treasurer; C. M. Reeves, vice-president; D. W. Clem, vice-president; C. L. Irwin, E. R. Baum, H. W. Randolph, H. B. Diehl, E. S. Redmerski, T. A. Bergen, P. C. Talbot, sales engineers.

Refractory & Engineering Corp.,
50 Church St., New York, N. Y.
Booth 74

This exhibit will present, as far as possible, the company's products in a way to show their actual application. It will be accomplished by small models on which the cements will be applied illustrating their use in actual practice, also by photographs of unusual applications which will prove of interest to visitors. The high temperature cements demonstrated will include the R. & E. brands as follows: No. 3000, Moldit, Moldit-A; No. 2700 SS, Hearth cement; and in insulations the following are the brands: Stic-Tite, Pakinsul, Pourinsul.

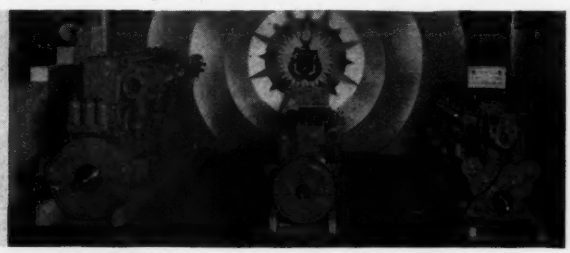
Representatives: H. N. Clark, Frank Christenson, R. H. Wheeler, C. P. F. Waidler.

Reliance Electric & Engineering Co.,
1042 Ivanhoe Rd., Cleveland, Ohio.
Booths 542-3

Products to be shown will include alternating-current motors in sizes up to 150 hp., direct-current motors in sizes up to 250 hp., open, fully-enclosed and fan-cooled motors of both types assembled and dismantled. The special feature will be the new Reliance Marine motor which is direct-current with water-tight construction for use in any section of a ship.

Representatives: J. W. Corey, sales manager; C. L. Peterson, advertising department, in charge; C. D. Herbert, New York district manager; J. W. Picking, J. S. Fenton, New York sales engineers; E. E. Helm, Philadelphia district manager; C. B. Allen, Philadelphia sales engineer; R. H. Smith, Boston district manager; J. L. Van Nort, Boston sales engineer.

Reliance Gauge Column Co., Booths 81-2
Cleveland, Ohio.



Republic Flow Meters Co., Booth 6
2240 Diversey Pkwy., Chicago, Ill.

This exhibit will feature a complete line of power plant and industrial instruments, including flow meters, Co_2 meters, draft instruments, liquid level gages, pressure gages, pyrometers and control pyrometers. Special features will be working models of flow meters, CO_2 meters and control pyrometers in operation, showing the latest developments in these types of instruments. Also there will be exhibited a display of large steel boiler panels and master panels featuring various combinations of flush-mounted reading instruments as well as a display of individual reading instruments.

Representatives: J. D. Cunningham, president; J. M. Spitzglass, vice-president; G. H. Hendrickson, sales manager C. W. Parsons, New York manager; C. E. Pritchett, Pittsburgh manager; Bryan Pritchett, Philadelphia manager; J. A. Morehouse, Boston manager; R. L. Morse, E. C. Horton, New York.

J. E. Rhoads & Sons, Booths 567-8
35 N. Sixth St., Philadelphia, Penna.

Riley Stoker Corp., Booths 79, 89
Worcester, Mass.

A new type of No. 4 Riley pulverizer will be exhibited, also a new type Riley cyclone burner and a new Jones side dump stoker with moving combustion grates. The exhibit will be so arranged that the operation of all apparatus can be demonstrated.

Representative: Robert J. Kruger, sales service manager.

John R. Robinson, Booth 613
110 W. 34th St., New York, N. Y.

Roller Bearing Co. of America Booth 251
Trenton, N. J.

This company has an unusual and attractive exhibit showing a range of sizes of its Heliflex anti-friction roller bearing for shafts from ⅜ to 13 in. For this particular display a novel feature will be a table made entirely of the flexible rollers used in bearings.

Representative: Olin L. Livingston, sales manager.

Roller-Smith Co., Booth 256
233 Broadway, New York, N. Y.

This company will exhibit a comprehensive line of alternating and direct-current electrical measuring instruments, in indicating and recording types, including switchboard and portable type ammeters, milli-ammeters, voltmeters, millivoltmeters, volt-ammeters, wattmeters, frequency meters, power factor meters, reactive factor meters, ohmmeters, bond testers and circuit testers. There will also be types of relays and an exhibit of air circuit breakers for alternating or direct current, high-voltage oil switches and breakers. A new line of graphic recording instruments will be specially featured, also the new oil switches and circuit breakers.

Representatives: G. L. Crosby, vice-president; J. E. Bevan, C. G. Kahant, S. H. King, W. J. Shire, New York office.

Rollway Bearing Co., Inc., Booth 2-N
Syracuse, N. Y.

In this exhibit the main feature will be a full size working section of a bridge truck wheel assembly of a large industrial crane. This will be cut away to show the new floating type Rollway bearing in action. In addition will be exhibited some larger radial bearings and also various types of thrust bearings as used in industrial machinery.

Representatives: Samuel Farrell, Pittsburgh; Schuyler Yates, Cleveland; H. E. Stratford, Chicago; C. A. Call, western New York and New England.

Rome Brass Radiator Corp., Booths 482-4
1 E. 42nd St., New York, N. Y.

This company will display its new Box Fin radiator in various assemblies, also its Aulbras indirect heaters and condensers. Improvements of the Robras Box Fin heater will be increased area of steam and water chambers, and an improved design of fins which are copper formed from a continuous sheet and sweated to the prime surface. Simplified arrangement of valves and traps on the longitudinal center line of the radiator will be shown. Arrangement of the Aulbras heaters and condensers for installation in any position either above, below or slightly above and partly below the water line and position to eliminate rust will be demonstrated.

Representatives: J. D. Erskine, president; J. A. Swan, vice-president; J. T. Burns, D. L. Mills, D. G. Noakes, W. F. Goodnow, W. D. Jamieson, J. A. Walsh.

Rotor Air Tool Co., Booth 653
5704 Carnegie Ave., Cleveland, Ohio.

Products shown will be a complete line of Rotor air tools, including portable grinders, portable drills, portable machines for buffing, sanding, nutsetting, screwdriving and similar operations. It will be an operating exhibit with compressed air furnished by a compressor from the Davey Compressor Co. New products shown will be a Rotor rod grinder for grinding valve links, side rods and the like, in railway shops; the B-O, a small disc sanding machine for sanding, buffing and polishing in automobile body finishing; also screwdrivers capable of driving screws up to 20 size in hardwood.

Representatives: K. L. Pohlman, vice-president; C. B. Scott, advertising manager; G. O. Singer, New York; F. D. Garber, Boston; A. T. Moulton, Philadelphia.

Rowan Controller Co., Booth 3-N
306 N. Holliday St., Baltimore, Md.

Joseph T. Ryerson & Son, Inc.,
Chicago, Ill. Booths 432-3

Sarco Company, Inc., Booth 33
183 Madison Ave., New York, N. Y.

Latest types of Sarco thermostatic steam traps, combination thermostatic and float type traps, temperature regulators and strainers will be displayed. There will also be specimens of the various Sarco Heating system specialties, including radiator traps, packless inlet valves, air eliminators, return traps, blast traps, and others. The Sarco temperature regulator will be demonstrated in actual operation.

Representative: E. J. Ritchie, sales manager, in charge.

Sauerman Bros., Booth 438
438 S. Clinton St., Chicago, Ill.

The special feature of this exhibit will be a working model of the Sauerman drag scraper system, storing and reclaiming coal on a ground storage area adjoining a power plant. The exhibit will include a Crescent scraper bucket and Durolite steel sheave blocks.

Representatives: John A. Schultz, Chicago; H. M. Cooper, New York, in charge.

W. J. Savage Co., Inc., Booth 654
Knoxville, Tenn.

One of the company's new Nibbler Type Gray Metal Cutters will be shown, Type No. 136, embodying latest features. It will have a throat depth up to 36 in., can be used for inside cutting in sheets having twice the width of the throat depth and is provided with turret head which permits the tool to be turned in the die.

Representatives: W. D. Cunnyngham, assistant sales manager, in charge; C. M. Swift, New York.

Sayre & Fisher Brick Co., Booth 547
Sayreville, N. J.

Schade Valve Mfg. Co., Booth 76
Philadelphia, Pa.

Schutte & Koerting Co., Booths 342-3
Philadelphia, Pa.

Spur gear and herringbone gear pumps will be shown in operation, also electric pressure control for motor-operated reducing valves. There will be sectional diagrams of motor-operated and hydraulically-operated Venturi reducing valves and a display of Radiafin tubes for heating and cooling work, oil coolers, oil strainers and special jet appliances. The sectional view will show construction and operating features of Venturi valves of new design, worked out to permit close regulation of reduced pressure without noise.

The electric pressure control will be connected to the sectional diagram of the motor-operated Venturi reducing valve and will operate to show how the valve motor is turned over momentarily or continuously to open or close the valve and to increase or decrease steam flow. The strainer exhibit will include a new duplex strainer, operated by a single plug cock.

Representatives: H. C. Woodward, K. K. Fischer, G. Heinemann, Philadelphia; C. T. Keet, W. E. Murdock, New York.

Schwenk Safety Device Corp., Booth 467
70 E. 45th St., New York, N. Y.

Safety handling equipment for barrels, drums and carboys will be shown, a loaded drum of 750 lb. weight being handled by one man.

Representatives: Merton E. Thayer, sales manager; I. C. Goldman, Melvin Pine, Max Adamsky.

Scovill Mfg. Co. Booth 69
Waterbury, Conn.

Scovill Cup Drawn condenser tubing, cap screws, brass, bronze and nickel silver sheet, rod, wire and tubing will make up the exhibit. The new Scovill method of securing the tubes into the tube sheet of condenser without the use of ferrules or packing will also be demonstrated.

Representatives: A. J. German; C. A. Gleason, Myron Rose, Carl Snowman, E. H. Callanan, Walter Taft, H. E. Needham, A. M. Rogers.

Scully-Jones & Co. Booth 266
Chicago, Ill.

Sharples Specialty Co., Booth 60
23rd and Westmoreland Sts., Philadelphia, Pa.

The company's standard lines of Sharples Super Centrifuges will be shown, also the latest developments in combination centrifuge and filter press outfits, combined portable trucks with pumps, heaters, and centrifuge, all mounted as an integral unit.

Representatives: H. H. LaMent, vice-president and sales manager, in charge; G. H. Lambert, assistant sales manager.

Shepard Niles Crane & Hoist Corp.
Montour Falls, N. Y. Booth 231

Products exhibited in this booth will include a close clearance hoist equipped with new design of motor-driven trolley, a compact hoist, photographic enlargements of installation views of the company's equipment in various industries and close-ups of the complete line of hoists and cranes ranging in capacities from ¼ to 450 tons.

Representatives: Robert T. Turner, sales manager; A. J. Barnes, Roy W. Hurst, Roscoe C. Vaughn, F. J. Muller, W. F. Serrick, Albert Drake, N. A. Hall.

Signal Engineering & Mfg. Co.,
154 West 14th St., New York, N. Y.
Booths 415-6

Silent Hoist Winch & Crane Co., Inc.,
762 Henry St., Brooklyn, N. Y.
Booths 548-9

Products to be shown will include Silent Hoist electric car pullers and barge movers, capstans, winches and hoists. Also there will be shown Silent telescopic hoists for ash removal, of hand and electric and crane type, Silent Hoist motor truck winches and cranes, worm-geared speed reducers, and cargo and dock winches. New products will include the telescopic ash hoist of which there are 5 models, the electric car pullers, one of capstan type and one of drum winch type.

Representatives: J. W. Wunsch, president; Samuel Wunsch, secretary; M. M. Botnick, sales department.

Simplex Valve & Meter Co. Booth 76
68th and Upland Sts., Philadelphia, Pa.

SKF Industries, Inc., Booth 223-4
40 E. 34th St., New York, N. Y.

Interesting devices will be featured showing the anti-friction qualities of SKF bearings, and in addition there will be on display a complete range of transmission appliances.

Representatives: R. H. DeMott, W. E. McIlroy, D. W. McAllen, J. D. Williamson, C. A. Decker, P. T. Hopper, P. A. Carlson.

F. L. Smidth & Co., Booth 318
225 Broadway, New York, N. Y.

This exhibit will demonstrate the advantages of the Lenix Short Center belt drive to show its application for various difficult situations.

Representatives: A. B. Zahn, assistant treasurer; V. Sahmel, B. Oberg, T. Offrel, electrical engineers; R. Salmonsen, A. E. Smith, O. Andresen, mechanical engineers; B. F. Clark.

David H. Smith & Sons, Booths 648-9
5111 Second Ave., Brooklyn, N. Y.

Here will be found an Angle Bending Rolling machine, Quadruple Combination punching and shearing machines, in two sizes, and demonstration of the operation of these machines.

Representatives: Dudley J. Smith, vice-president; George H. Kennedy, Jr., manager machinery sales; John Frazer, service department.

Smith Monroe Co., Booth 274
South Bend, Ind.

Smith-Serrell, Booths 85-6
Globe Indemnity Bldg., Newark, N. J.

Fred Smyder, Booth 652
56-13 59th Pl., Maspeth, L. I., New York.

Tools for wood workers and iron workers, especially for welders, will be the display in this exhibit. Quick Screw clamps and woodworkers tools will be shown, also the new universal clamp for quick action and double grip in awkward locations.

Representative: Fred Smyder.

Snap-On Tools, Inc., Booth 453
Kenosha, Wisc.

Special wrenches of various forms will make up the display in this booth, including socket, adjustable, tappet, open end, Boxocket and pipe wrenches. Other tools shown will include hammers, pliers, punches, chisels, screw drivers, feeler gages, wheel pullers and files. An attractive feature will be a special electrically-lighted map of the United States showing the territories of the different salesmen and the locations of branch warehouses, also the sites of the three factories. A new product of special interest to power engineers is the No. 73 giant ratchet wrench developed especially for strength and ease of operation. The

Boxocket wrenches are made with detachable tubular handles and have nut openings up to 3½ in. across the flats.

Representatives: C. H. Tennyson, Kenosha; T. N. Glenn, Boston; E. A. Glenn, Pittsburgh; F. A. Hoster, Philadelphia.

South Bend Lathe Works, Booth 401
South Bend, Ind.

In this booth will be exhibited new model South Bend Lathes in operation including a 9 in. by 3 ft. New Model Jr. motor-driven lathe, a like model for bench mounting and a 16 in. by 6 ft. New Model Precision toolroom lathe. The Junior Model lathes are for machining a small line of work such as comes up in power plant repairs and for small experimental work. The 16 in. Precision lathe is used for production manufacturing work and in toolrooms for machining tools, dies, jigs, and the like.

Representative: L. O. Stephenson, factory representative.

Springfield Facing Co., Booth 27
351 Jefferson St., Newark, N. J.

Square D Co., Booths 442-3
6060 Rivard St., Detroit, Mich.

Industrial control apparatus, including across-the-line starters, primary resistor starters, compensators, both hand and automatic and pressure switches will be displayed; also Square D material, including line disconnects, meter switches, lighting panels, power panels and a voltage tester.

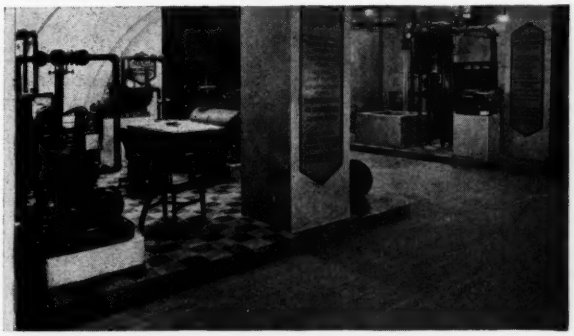
Representative: W. J. Wickenheiser, branch sales manager, in charge.

Standard Motor Construction Co.,
172 Whiton St., Jersey City, N. J.
Booth 601

Standard Oil Co. of New York,
230 Park Ave., New York, N. Y.
Booths 207-9

This exhibit will give an attractive display of petroleum products as used by various industries. Industrial lubricants will be specially featured and a Socony motor oil introduced November 1, of this year, will occupy a prominent place.

Representatives: S. W. Mudge, sales manager Lubricating oil department; F. C. Sheridan, B. E. Baker, assistant sales managers; N. C. Butler, Jr., consulting engineer; L. A. Herrmann, cutting oil specialist; E. J. Milligan, R. C. Gunther, engineers.



W. K. Sowdon & Co., Inc., Booth 76
342 Madison Ave., New York, N. Y.

This company will act as agent for the National Co., Inc., Schade Valve Mfg. Co. and the Ernst Water Column & Gage Co. It will exhibit water column gage glass illuminators, especially the new type L National illuminator for flat type gages, and electric compartment cell door hardware. The exhibit will also include steam, water, air and oil specialties, including pressure-reducing valves, regulators, altitude valves, relief valves, and pressure controls. Water level gages, inclined and vertical, particularly gages for high pressures will also be shown.

Representatives: Grayson Smith for the National Co., Inc.; F. H. Jones for Schade Valve Mfg. Co.; George Ernst for Ernst Water Column & Gage Co.

Spencer Turbine Co., Booths 516-7
Hartford, Conn.

Spencer Turbo Compressors for supplying air in connection with oil and gas burning industrial furnaces, foundry cupolas, and the like will be shown. A 5 hp. Turbo with casing and end head made of stainless steel and impellers of Duralumin will be seen in operation. This is designed particularly for handling injurious gases and acid fumes. In addition, a vacuum producer used in central vacuum cleaning systems for industrial work and large buildings will be demonstrated in operation.

Representatives: H. H. Richardson, president; E. J. Skillman, New York representative; E. A. Wright, special representative; R. A. Brackett, sales department.

Stanley Electric Tool Co., Inc.,
New Britain, Conn. Booths 457-8

Several new portable electric tools will be displayed here, including drills of 14 different types with chuck capacities from 3⅛ to ⅞ in., together with drill stands and accessories; grinders of bench and pedestal types, the smaller ones for tool grinding and the larger ones for heavy duty factory work; new and improved hammers in sizes of 1⅛ and 2 in. capacity; safety saws, including motor and air-driven saws with capacities from 1⅞ to 6 in., in wood; stone saws for cutting tile, marble, limestone and the like; Stanley unishears for cutting sheet materials, the larger sizes handling up to ¼ in. boiler plate; screw drivers for driving screws and running on nuts.

Representatives: R. W. Chamberlain, sales manager; K. B. Guy, O. E. Marthinson, William Ernst, E. J. Hatch, H. J. Heller.

Star Expansion Bolt Co., Booth 202
147 Cedar St., New York, N. Y.

Here will be found a full line of expansion shields, including the Dryvin, Tampin, Loxin; Springin toggle bolts, and Scruin Lead Screw anchor. Other details will be drills and kindred products, also various installations of expansion shields in different types of masonry construction. A special feature will be a testing machine to demonstrate the tension of any product in concrete or brick.

Representatives: Harry Fox, eastern district sales manager, in charge; R. M. Taylor, W. E. Mercer.

L. S. Starrett Co., Inc. Booth 456
Athol, Mass.

This company will display a representative assortment of its products including steel tapes, transit and leveling instruments, tungsten and high-speed-steel hacksaws; new tools, such as master precision level, extension tap wrench, cutter clearance gage, new type micrometer depth gage and junior cylinder gage. These tools will be specially featured and demonstrated and the uses of all apparatus clearly shown.

Representatives: David Findlay, general sales manager; W. J. Greene, eastern sales manager, G. R. Christie, T. B. Hogben, W. J. Clark, Harold Christensen, A. S. Collins, W. R. Barlow, W. B. Landis.

Staynew Filter Corp., Booths 419-20
Rochester, N. Y.

Protectomotor, high efficiency air filters for every purpose will be exhibited in this space, including industrial air filters, panel type of filter, industrial manifold type, upright unit and special applications for collecting dust locally from machines and for filtering liquids in pipe lines.

Representatives: L. L. Dollinger, president; Eugene J. Cantin, New York, manager; C. F. Hasselwander, Rochester.

Sterling Engine Co., Booth 64
1270 Niagara St., Buffalo, N. Y.

The features this company will exhibit are a Dolphin 6-cylinder model, the Petrel 6-cylinder model and the Viking 11 8-cylinder model of gasoline stationary combustion engines. The sizes run from 5¼ by 6 up to 8 by 9 in., the horsepower ranging from 80 to 565. Details of construction will be fully demonstrated.

Representatives: C. A. Criqui, C. A. Criqui, Jr., advertising manager; M. E. Mutchler, W. E. John.

Stockham Pipe & Fittings Co.,
Birmingham, Ala. Booths 485-6

Sumet Corporation, Booth 507
1543 Fillmore Ave., Buffalo, N. Y.

Here will be shown a unique demonstration with five bearings of Actenized Sumet bronze in operation. A cold rolled steel shaft will run at 3,000 r.p.m. at 600

deg. F., the temperature being shown by a thermometer; another shaft will be run dry and another with steam lubrication only at 215 deg. Two will be shown as a test for water lubrication only.

Representatives: H. O. Warner, sales manager; A. A. Matthews, sales engineer.

Sundh Electric Co., Inc., Booths 435-6
Parkhurst St. at Avenue C, Newark, N. J.

Superheater Co., Booth 57
60 E. 42nd St., New York, N. Y.

Model to scale will be exhibited of one of two 1400 lb. semi-vertical boilers with Elesco superheaters as now being installed at the Ford Motor Co. plant. A large sectional lay-out of this and other Elesco intertube and interdeck superheaters will be exhibited, also a sectional drawing of an Elesco desuperheater.

Representatives: F. A. Schaff, president; R. M. Gates, vice-president; L. H. A. Weaver, publicity manager; V. W. Smith, W. T. Conlon, D. S. Carter, B. R. Bristol, R. L. Ehmann, R. S. Cooper, W. H. Armacost, C. W. Gordon, sales engineers.

Swartwout Co., Booth 75
18511 Euclid Ave., Cleveland, O.

Products shown will be feedwater regulators; differential pressure, pressure regulating and safety shutoff valves; pump and desuperheater governors; waster controls, steam separators, exhaust heads, feed-water heaters, high and low-pressure traps. The carburetor type desuperheater will be specially featured; it is a new product using the atomization principle of the automobile carburetor and, with the governor, giving close control of temperature. Demonstration will be made of the action of a master controlled regulating valve to reduce high temperatures and pressures to low values with definite results.

Representatives: D. K. Swartwout, vice-president; H. S. Fraser, New York manager; H. C. Miller, L. P. Russon, Cleveland; J. W. Johnson, P. R. Jones, New York.

Syntron Co., Booth 638
90 West St., New York, N. Y.

C. J. Tagliabue Mfg. Co., Booth 59
Park & Nostrand Aves., Brooklyn, N. Y.

New and improved instruments will be exhibited in this space, a complete line of TAG recording and controlling, round form, flush-mounted types for power plant panel board installation. There will also be a new Mono Indicator Recorder, all metal type, for indicating and recording the percentage of carbon dioxide and carbon monoxide in flue gases. A special feature will be a Heppenstall Moisture Meter, a device for sorting out wet stocks and indicating moisture content of lumber. Another line to be featured will be industrial thermometers of various forms with the Hespe easy reading red column showing above the mercury. Barometers, U-gages, pressure gages, recording thermometers and pressure gages, etched-stem thermometers and hydrometers will be shown.

Representative: Victor Wichum, chief engineer, in charge.

Taylor Instrument Cos., Booth 323
Rochester, N. Y.

A full line of temperature and pressure instruments will be displayed. Special emphasis will be given to the Tycos Flush Mounted instruments, including recording thermometers or pressure gages for one, two or three pens, or for any combination, so that for example, two temperature records and one pressure reading may be shown on the same chart. These instruments have connections made from the back of the panel. Included in the exhibit will be recorder regulators for desuperheaters, index thermometers, pyrometers, mercurial barometers, vacuum gages and other instruments.

Representatives: J. E. Ely, vice-president and sales manager; L. B. Swift, chief engineer; J. W. Schwarz, manager of power plant sales, C. B. Carson, manager of recorder sales; W. N. Maurer, W. J. Marlborough, H. W. Kugler, W. E. Roubie, J. E. Connors, New York.

Templeton Kenly Co., Booth 290
Chicago, Ill.

Templeton Steam Trap Co., Booth 272
77 Cortlandt St., New York, N. Y.

Texas Co., Booths 514-5
135 E. 42nd St., New York, N. Y.

Thomas Grate Bar Co., Booth 251
Birmingham, Ala.

Products to be shown by this company will be working models of the Thomas WSD Grate equipment for burning bituminous and anthracite, also for wood refuse and mixture of wood refuse and coal. The WSD stands for Wiggling-Shaking-Dumping and the grate is so made that it may be installed either level or on an incline as desired. The exhibit will also include the Thomas Elliptic and Thomas Durable stationary grates, showing full size parts as well as complete working models.

Representative: Grant L. Thomas, Cleveland, district manager.

Tide Water Oil Sales Corp., Booth 15A
11 Broadway, New York, N. Y.

Time-O-Stat Controls Co.,
Elkhart, Ind. Booths 300-2

A complete line of automatic controls for gas, coal and oil-fired equipment will be shown. Details will be displayed to show primary controls for oil burners, gas valves, limiting devices, room thermostats, safety pilots and individual room temperature controls. A representative display of sign flashers will also be demonstrated.

Representative: B. W. Dezotell, New York manager.

Timken Roller Bearing Co.,
Canton, Ohio. Booths 332-3

Featured in this exhibit will be a display to show the capacity of bearings for carrying thrust loads, as well as the reduction effected in friction. This will consist of a steel mill bearing. weighing about 500 lb., mounted on a vertical shaft and the whole suspended weight carried by a small bearing. This shaft will be driven by a fractional horsepower motor, using a fish line for a belt. There also will be displayed an assortment of bearings of different sizes, including one of the new steel mill bearings, the largest so far built.

Representatives: L. M. Klinedinst, vice-president; S. C. Merrill, New York district manager of industrial sales; F. B. Yates, New York; W. P. White, Philadelphia district manager of industrial sales.

Toledo Pipe Threading Mach. Co.,
Booths 444-5
1425 Summit St., Toledo, Ohio.

This company will display a complete line of hand-operated threading and cutting tools in sizes from ⅛ to 12-in. There will also be pipe machines for cutting and threading in sizes from ½ to 2-in. and a line of vises, vise mounts and work benches. The Toledo power drives for operating geared threaders or cutters by electric power will be demonstrated, also the No. 999 portable Toledo pipe machine.

Representatives: Clarence A. Popp, eastern manager of sales, in charge; F. D. Stuart, J. E. Booth, C. E. Brokaw.

Topping Brothers, Booths 288-90, 520-3
159 Varick St., New York, N. Y.

Torchweld Equipment Co., Booth 290
224 North Carpenter St., Chicago, Ill.

Gas welding and cutting equipment will be demonstrated, also a new gasoline and oxygen cutting torch recently put on the market.

Representatives: W. A. Slack, president; H. Edge, James H. Browning, Allen Topping, R. Spinney, M. S. Moody.

Triplex Machine Tool Co.,
50 Church St., New York, N. Y.
Booths 402-3

Here will be shown a type of improved Swiss Jig Boring Machine, new both in size and design but not a new type of tool.

Representatives: John Cetrule, Nicholas Cetrule, R. Y. Ferner.

Troy Engine & Machine Co., Booth 15B
Troy, Pa.

A Troy Type SH heavy duty vertical steam engine will be shown with glass plates in the sides so that operation of the moving parts can be easily observed, the engine being turned over slowly to aid in the study of its performance.

Representatives: F. F. van Buseck, F. J. Vonachen, Troy, Pa.; D. J. Rowland, New York.

Trumbull Elec. Mfg. Co., Booths 608-9
60 E. 42nd St., New York, N. Y.

Uehling Instrument Co., Booth 217
473 Getty Ave., Paterson, N. J.

Featured will be a new potentiometer pyrometer just on the market; also the company's combined barometer and vacuum recorder for condensers and vacuum stills. Simplified and perfected Apex CO_2 equipment, electrically operated, will be displayed with motor-driven vacuum pump and oil regulator which eliminates all steam, water, exhaust and drain lines.

Representatives: F. F. Uehling, P. J. Riccobene, C. J. Schmid.

The United States Electrical Tool Co.,
Cincinnati, Ohio. Booths 408-10

Products shown will be drills and grinders for plant maintenance, demonstrating the unusual power in drilling of an electric drill and stand. The weight of several people can be exerted on the handle of a drill stand without wavering the power of the drill.

Representatives: W. B. DaSilva, in charge; R. T. Watts, Frank Lenox, H. B. Griner.

Universal Metals Bearing Corp.,
Booth 288
159 Varick St., New York, N. Y.

Van Dorn Electric Tool Co., Booth 522-4
Towson, Maryland.

Special tools, including electric drills and drill presses, portable electric saws and hammers, electric tappers, flex-disc grinder or sander and polishers, screw drivers and nut runners, valve refacer and

reconditioning equipment, High-Cycle super production tools will constitute this display. The tools will be demonstrated in actual working operation.

Representatives: E. M. Benson, H. B. Costantin; E. M. Stuart, New York manager.

Veeder-Root Inc., Booth 324
Hartford, Conn.

This company will display a general line of counters for power and mechanical fields, of both mechanical and magnetic design and for light and heavy duty work.

Representatives: A. E. Kallinich, field sales manager, in charge; J. E. Langendorfer, sales engineer; Joseph T. Quinlan.

Henry Vogt Machine Co., Booths 269-70
Louisville, Ky.

Products to be shown in this space will include D. F. Steel valves and fittings, the Vogt boiler and details of construction, the Vogt refrigerating machinery and descriptions and photographs of installations.

Representatives: R. S. Woolf, W. S. Cannon, Jr.

The Vulcan Soot Cleaner Co., Booth 204
DuBois, Pa.

Ratchet and Vulcan Valve Operating Heads will be shown, also miscellaneous cleaner parts. The heads will be mounted on a section of boiler wall and will be in continuous operation. Advantages of the devices will be fully described in catalogs available.

Representatives: F. W. Linaker, vice-president; W. C. Ihde, general sales manager; C. H. Baker, P. Richardson.

Wailes-Dove-Hermiston Corp., Booth 260
17 Battery Pl., New York, N. Y.

J. D. Wallace Co., Booth 647
134 S. California Ave., Chicago, Ill.

Workace tools will make up this display. Among these will be an electric woodworker, a radial saw, a shaper, a bandsaw, a jig saw and a Kut-N-Jigger. The electric woodworker is a home workshop device for light industrial use. The Kut-N-Jigger is shown for the first time and is a portable electrically-driven jig saw for either wood or metal cutting and can also be used as a filing machine.

Representative: J. B. Murphy, New York district manager.

Walworth Co., Booth 90
Statler Bldg., Boston, Mass.

This exhibit is built around the new Walco wrench of drop forged steel with frame integral with the bar. Specially featured will be a series of tests to demonstrate the strength and gripping qualities of this wrench. There will also be a demonstration of Chrome-Nickel-Iron cast pipe.

Representatives: F. W. Duemler, vice-president; J. D. Mattimore, Howard Coonley, Jr., G. R. Galbraith, F. M. Churchill.

Ward Leonard Electric Co., Booth 512-3
Mt. Vernon, N. Y.

Vitrohm and Ribohm resistors and rheostats, Vitrohm dimmers, magnetic relays, motor starters and controllers and sound control equipment will make up this exhibit, arranged on 5 panels for convenient inspection. Exhibits may be operated by visitors to observe the action.

Representative: A. A. Berard, sales manager.

Watts Regulator Co., Booth 39
250 Lowell St., Lawrence, Mass.

This year's exhibit will consist of the Watts boiler feeder of simplex and duplex types, a new product of the past year; also the company's general line of steam specialties, including damper regulators, feed-water regulators, reducing valves, pump governors, relief valves and other devices. Actual demonstration will be made of the operation of many of the specialties.

Representatives: B. E. Horne, Lawrence, Mass., in charge; Chetwood Smith, W. M. Dillon, Boston; Charles C. Phelps, steam specialties, John G. Kelly, H. C. Schmidt, New York.

F. M. Webber Co., Booth 211
420 Lexington Ave., New York, N. Y.

Various types and sizes of Charavay Airplane propeller fans will be shown as made by the Hartzell Propeller Fan Co. Fans will be shown in sizes from 12 to 60 in., including various sizes of wall type exhaust fans, extension shaft units, Kool Blast fans; all exhibits will be wired up so that the fans can be operated.

Representatives: F. M. Webber, manager; J. F. Cermak, E. A. Dugan, New York; P. G. Peddicord, sales manager, Hartzell Propeller Fan Co.

Warren Webster & Co., Booths 225-6
Camden, N. J.

Webster Moderator system, the Improved vacuum system and the Improved Type R system of steam heating will be shown. New equipment for the Webster system will include the Webster Hylo Variator for use with the new Improved Webster vacuum system, also the Webster Three-Point valve and the Webster boiler protector.

Representative: B. F. Lerch, assistant advertising manager.

Westinghouse Electric & Mfg. Co.,
East Pittsburgh, Pa. Booth 68

This company's space will be occupied by the Stoker Department with demonstration of its various products.

Weston Electrical Instrument Corp.,
Newark, N. J. Booth 234

Products to be shown here will be a relay table and electrical measuring instruments with their accessories for all kinds of power plant electrical measurements.

Representative: C. B. Denton, in charge.

Whitney Metal Tool Co., Booths 454-5
Rockford, Ill.

Wilson Welder & Metals Co., Booth 433
Hoboken, N. J.

L. J. Wing Mfg. Co., Booth 61
154 W. 14th St., New York, N. Y.

Wing turbine and motor-driven forced draft blowers, Wing turbine-driven centrifugal blowers for gas producers, Intensi-Fire system for burning buckwheat fuel in domestic furnaces, Featherweight unit heaters, fans and exhausters, will be displayed in this space. Among the special features will be the new high-pressure heating element for the Featherweight unit heaters and the demonstration of the Intensi-Fire system for domestic furnaces.

Representatives: Alfred E. Seelig, president and general manager; Harry S. Wheller, vice-president; I. F. Goodfriend, G. W. Gale, John Brower, James Carbone, C. L. Meyer, A. W. Smith, T. R. Peyrek, J. M. Hancock.

Wolverine Tube Co., Booth 211
420 Lexington Ave., New York, N. Y.

Woodworking Machinery Co., Booth 637
103 Lafayette St., New York, N. Y.

Wright-Austin Co., Booth 28
2231 Park Ave., Detroit, Mich.

High-pressure forged steel steam traps and water columns will be specially featured. Also three types of traps, steam and oil separators, water columns and gages, exhaust heads and strainers will be displayed.

Representatives: C. Burt Walter, president; Henry Dusenberry, New York district manager; A. C. Smith, C. G. Heydon.

Wright Manufacturing Co., Booths 346-7
Bridgeport, Conn.

This company will show hoists, trolleys and cranes for all purposes in power plants and factories.

Representatives: George A. Nichols, George N. Walton, Charles Walton, R. F. Straw.

Yale & Towne Mfg. Co., Booths 425-6
Stamford, Conn.

Yale Electric industrial trucks, tractors, and trailers; complete overhead material handling equipment, including Yale chain blocks and trolleys, both hand and electric operated, also cranes and the Yale line of Stuebing hand lift trucks and skid platforms will be displayed. Special attention will be given to make this a most complete arrangement of material handling equipment in a single exhibit.

Representatives: James C. Morgan, C. O. Hedner, C. B. Veit, W. L. Burghardt, Gordon C. German, B. M. Zwart, J. J. Morris, M. G. Peck, R. E. Wilson, W. F. Redmond, Phil E. Hofer, H. S. Pierson, W. F. Randall.

Yarnall-Waring Co., Booth 52
Chestnut Hill, Philadelphia, Pa.

Various types of Yarway floatless Hi-Lo alarm water columns and Sesure inclined gages will be shown using both round and flat glasses for low and high pressures. Also there will be displayed a full line of Yarway tandem blowoff valves for all working pressures up to 2000 lb. including sectioned samples; Yarway Cylinder Guided expansion joints sectioned to show internal construction; Yarway hydraulic valves of single and two pressure types for pressure up to 5000 lb.

Representatives: L. B. Chase, New York district manager; D. T. Newman, sales engineer; A. L. Aicher, mechanical engineer.

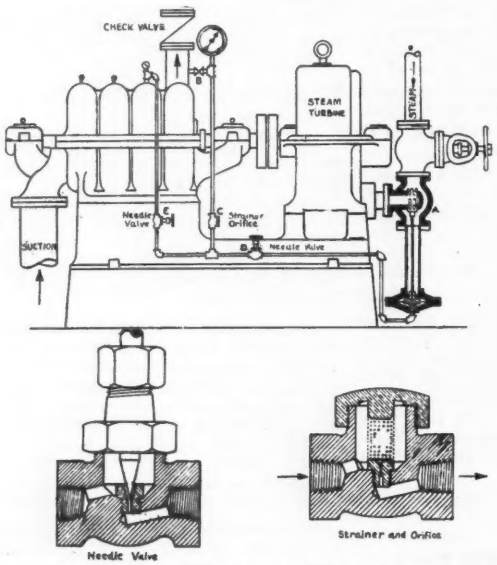
Youngstown Sheet & Tube Co.,
Youngstown, Ohio. Booths 275-6

Here will be found a model of a Buttweld furnace, believed to be the only one in existence and of decided interest in showing in detail just how buttweld pipe is made.

Representative: M. S. Curtis, manager of sales promotion, in charge.

Excess Pressure Regulator

USING A SYSTEM of leak-off, instead of a long column of mercury, Mercon Regulator Co. of Chicago, Ill., has developed the new excess pressure regulator illustrated which, although simple, is sensitive, effective and controlled readily. Steam-control valve A, is of the balanced piston type operated by a thick diaphragm of relatively large area. Space is allowed above the diaphragm to condense the steam thereby keeping the diaphragm cool. A ¼-in. pipe connection, which includes a globe or gate stop valve, B, an orifice and strainer, C, and a needle valve, D, is made from the discharge of the pump or from some point in the feed header, to the lower part of the diaphragm chamber.



LEAK-OFF CONTROLS NEW REGULATOR

From one of the intermediate stages of the pump, usually next to the last stage, a ¼-in. pipe connection is made to a point between orifice, C, and needle valve, D. Another needle valve, E, similar to D, is installed in this second pipe connection. With valve E closed, D open and the main steam throttle opened, full steam pressure is applied above the diaphragm, forcing the diaphragm downward and holding the control valve open until the pressure developed at the discharge of the pump is equal to the steam pressure, thus balancing the diaphragm. Any further increase of feedwater pressure tends to close the steam valve hence reduce the pump speed.

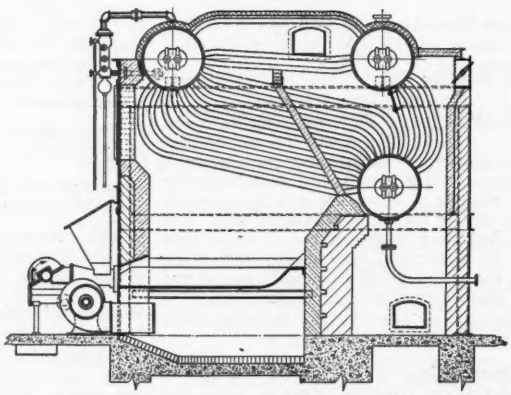
If, now, the needle valve E is opened slightly, some water will leak to the lower pressure stage, thereby reducing the pressure under the diaphragm slightly, causing the steam valve to open and increasing the pump speed until enough additional pressure is developed at the pump discharge to compensate for the leakage and balance the pressures. Now, the pressure at the discharge of the pump is somewhat higher than formerly and there will be a moderate differential of feed pressure above steam pressure. Opening valve E further will increase the amount of control valve opening, consequently the pump discharge pressure and differential. Any differential between zero and the head developed by the last stage of the pump can be obtained and once set this differential remains constant at all loads and steam pressures.

Strainer and orifice may be cleaned while the regulator is in service by closing needle valve D, thus holding the diaphragm in whatever position it may happen to occupy at the time. Valves E and B then are closed, the cap removed from C and the tubular strainer lifted out and cleaned while, by opening needle valve E, a backwash under high pressure is created to clear the orifice. Cleaning and reassembling may be carried on with the pump in operation after which needle valve D is opened for regular operation.

L-Type Three-Drum Boiler

DESIGNED ESPECIALLY for medium-sized installations and limited space conditions, the L-type three-drum bent-tube boiler shown here has recently been placed on the market by Union Iron Works, Erie, Pa. These boilers are built in sizes from 90 hp. up and for a wide range in working pressures.

The design incorporates distinctive features intended to insure efficient steam generation at all ratings. The two upper drums are located on the same horizontal center line, in order to give the maximum steam disengaging surface in the front drum and to allow full steam liberation without any restriction. The upper



CROSS-SECTION THROUGH L-TYPE BOILER

drums are connected by two rows of water carrying tubes to produce a circulation similar to that in cross drum boilers and to maintain a steady water level in both drums. The steam passes to the rear drum through tubes carrying only steam, so that it may receive thorough drying out and some superheat.

Gas tight monolithic baffles are used to give a cross flow of the gases through the tube bank and to produce minimum draft loss and uniform gas velocity.

A full steel suspension is regularly furnished, as standard equipment, to carry the entire weight of the boiler.

The L-type boiler is designed to be extremely compact and to be shipped completely shop assembled in many sizes. The boiler is carried in transit in the upper portion of the structural frame and the lower legs are later bolted in place in the field.

Death of H. H. Dow

HERBERT HENRY DOW, president of Dow Chemical Co., Midland, Mich., died on Oct. 15 at the Mayo clinic in Rochester, Minn. Dr. Dow was born in Belleville, Ont., in 1866, received his early education in Cleveland, Ohio, and graduated at the Case School of Applied Science in 1888. After graduation he went to Midland to investigate the brine deposits there, developed an electrolytic process for extraction of bromine from brine and in 1897 established the Dow Chemical Co.

His inventive capacity led to the development of numerous processes and equipment for chemical production and he was granted over 100 patents for these. Although his education and chief interest lay in chemistry, he had been greatly interested in his father's work on the steam turbine and his interest in thermodynamics, he stated, was of great value in working out chemical problems. He was granted an honorary degree in mechanical engineering by the University of Michigan and Case School made him honorary doctor of engineering. He was awarded the Perkin medal for 1930, the highest award in chemistry.

Martin J. Insull Speaks at Opening of South Amboy Station

SPEAKING on The Public and Power, Martin J. Insull, president of the Middle West Utilities Co., gave the principal address on Oct. 31 at the official opening of the new $6,500,000 generating station of the Jersey Central Power & Light Company in South Amboy, N. J. The South Amboy Station was described in detail in the July 15, 1930, issue of Power Plant Engineering.

The opening was held before a gathering of about 300 civic officials and public utility executives. Following addresses by Mr. Insull and officers of the company, the governor of New Jersey, Morgan F. Larson, threw a switch putting the new 50,000-kw. station into regular service.

Designed to be highly efficient in itself, the new station will also add measurably to the economy of the entire Jersey Central system, it is stated. It is situated about midway between the company's northern and southern divisions, formerly isolated operations. Transmission lines uniting both divisions with South Amboy will make the plant base load station for a single, interconnected system.

Jersey Central Power & Light Co. is a subsidiary of National Public Service Corp. and part of the Middle West Utilities System.

Dedication of the New James H. Reed Power Station

FIFTY YEARS of public service in the Greater Pittsburgh district was marked when, on Thursday, October 16, United States Senator David A. Reed delivered the dedication address at the James H. Reed Power Station exercises and James D. Callery, president of the Diamond National Bank and former president of the Philadelphia Co., set the gigantic machinery of the plant into motion.

Five hundred leading citizens of the Steel City were on hand to attend the ceremonies, in addition to a large delegation of out-of-town visitors who came to the city expressly to witness the opening of the $10,000,000 station on Brunot Island, named in honor of the late Judge James H. Reed, a former officer of the Duquesne Light Co. The James H. Reed Station was described in detail in the April 1, 1930, issue of Power Plant Engineering.

The dedication exercises not only marked the golden anniversary of the light company but they were heard by thousands of radio listeners who tuned in on the broadcast of KDKA, delivered by Louis L. Kaufmann, of the Westinghouse Co. Officials of H. M. Byllesby and Co., the Byllesby Engineering and Management Corp., and the Philadelphia Co. and Affiliated Corporations from various parts of the United States were on hand to witness and take part in the exercises. The son of the man for whom the station was named was the principal figure present. A former president of the Philadelphia Co., Mr. Callery, had the honor of starting the machinery by passing his hand over a Knowles grid-glow relay.

Red Cross Roll Call

AT THIS TIME each year, the Red Cross appeals for renewal of memberships and for new members. Its active work has been assistance in Drought Relief, in Santo Domingo hurricane relief, help to disabled ex-service men, instruction in first aid, and meeting needs as they arise from disasters in all parts of the country. Their work is well worthy of support and contributions in any amount are welcomed.

News Notes

NATIONAL SAFETY COUNCIL, 20 No. Wacker Drive, Chicago, Ill., announce the following new officers for its refrigeration section: General Chairman—Vincent Wakefield, City Ice Co. of Kansas City, Kansas City, Mo.; Vice-Chairman—Frank L. Duggan, Consolidated Ice Co., Pittsburgh, Pa.; Vice-Chairman—W. M. O'Keefe, Cold Storage Division, American Warehousemen's Association, Chicago, Ill.; Secretary and News-Letter Editor—Edward H. Fox, Secretary, National Association of Practical Refrigerating Engineers, 435 N. Waller Ave., Chicago, Ill.; Chairman Poster and Slides Committee—George C. Baker, Consumers Co., Chicago, Ill.; Chairman Membership Committee—B. B. McCulloch, Bureau of Safety, Chicago, Ill.; Chairman Statistics Committee—Herman Hillenbach, American Ice Co., care of Knickerbocker Ice Co., New York City; Chairman Engineering Committee—Emerson A. Brandt, Middle West Utilities Co., Chicago, Ill.

Executive Committee consists of the officers and: Gardner Poole, General Seafood Corp. (5 Fish Pier) Boston, Mass.; George A. Pardee, National Ass'n Practical Refrigerating Engineers, Louisville, Ky.; A. H. Baer, Frick Co., Waynesboro, Pa.; Leslie C. Smith, National Ass'n of Ice Industries, Chicago, Ill.; E. G. Hitt, Chicago District Ice Association, Chicago, Ill.; Fred Rasmussen, International Ass'n of Ice Cream Manufacturers, Harrisburg, Pa.; A. J. Authenrieth, Middle West Utilities Co., Chicago, Ill.; J. F. Nickerson, American Institute of Refrigeration, Chicago, Ill.

THOMAS R. WEYMOUTH, of Tulsa, has resigned as chairman of the Board of Oklahoma Natural Gas Corp. and also as president of the Natural Gas Engineering Corp., effective November 1, to accept a position as vice-president of the Columbia Engineering & Management Corp. with headquarters in New York City. Mr. Weymouth became president of the Oklahoma Natural organization in 1928 and chairman of the board this year.

CHICAGO PNEUMATIC TOOL CO. of New York announces the completion of its new sales and service building at 570 East Larned St., Detroit, Mich. The building, which is of reënforced concrete faced with tapestry brick, contains about 12,000 sq. ft. of floor space, including a warehouse for the company's products, repair and service shops and office section.

A. H. SHAFER has recently been appointed manager of The Foxboro Co.'s Pittsburgh office, replacing H. S. Gray, who is now in charge of office routine at the home plant at Foxboro, Mass.

BAILEY METER Co., Cleveland, Ohio, announces the opening of an office in Seattle, Washington, at 406 E. 80th St., under the management of L. E. Evans. The company announces that C. E. Albert has been appointed manager of the Kansas City office located at 1010 Coca Cola Bldg., Kansas City, Mo. Mr. Albert was previously located with the Houston office, Texas.

LINCOLN ELECTRIC Co. announces the appointment of W. S. Stewart as district manager in charge of Cleveland, O., territory with offices at Cort Road and Kirby Ave.

NATIONAL POWER CONSTRUCTION Co., Chicago, Ill., announces the removal of its office to Suite 1142 at 20 North Wacker Drive.

WORTHINGTON COMPANY, INC. announces the removal of its El Paso District office to 206 San Francisco St.

REPUBLIC STEEL CORP. has received an order from the Biggs Boiler Works, Akron, Ohio, for Toncan iron plates to provide one mile of water pipe for the city of Detroit. The pipe will be produced by the Biggs company by the electric welded process. The pipe will be fabricated in 32-ft. lengths without circumferential seams. The field joints will be made with Dresser couplings. The plates from which the pipe will be made will be ½ in. in thickness, 114¾ in. wide, 383⅝ in. long, requiring one such plate to make a standard 32-ft. section. The pipe will be hot tested, preheated and vertically hot dipped.

LINK-BELT Co. announces that it has closed a contract for a powdered coal system at its Indianapolis Foundry with a building to house the system and alterations in the plant. Preparation for future business is given as the reason for adding this equipment at the present time. The system will modernize the process of firing the melting and annealing furnaces and the heating of the boilers. Alfred Kauffmann, President of Link-Belt, stated, "Now, during the slack production period, is the time to perfect manufacturing processes and prepare for future business. We believe in practicing what we preach."

A. H. ARMSTRONG, assistant engineer of the railway department of the General Electric Co. for many years and more recently chairman of the railroad electrification committee, and consulting engineer for the transportation department, has established a private consulting engineering office at 16 Troy Road, Schenectady, N. Y.

Mr. Armstrong was graduated from Worcester Polytechnic Institute in 1891, and entered the employ of the Thomson-Houston Co. at Lynn, Mass., in the same year. He joined the railway engineering department of the General Electric Co. in 1897 and since that time has devoted most of his energies to the study of railroad problems.

He is a member of the American Institute of Electrical Engineers, the National Electric Light Association, the American Electric Railway Association, the American Railway Engineering Association, and other societies. Mr. Armstrong retired from the General Electric Co. on November 1 and took up immediately his private consulting engineering work.

Books and Catalogs

MY AUTOMOBILE: ITS OPERATION, CARE AND REPAIR. By Harold F. Blanchard, Technical Editor of "Motor," published by Scientific Book Corporation, 15 East 26th St., New York City; 6 by 9 in.; flexible cover, second edition revised, enlarged and entirely reset; 387 pages, 227 illustrations; price, $3.50.

This book was written for two classes of persons: those with little mechanical ability who desire simple instructions for locating and curing engine troubles and those mechanically inclined who wish to acquire thorough knowledge of how any car works. It is a handbook for automobile owners and drivers which describes the care and operation of all types of cars.

Symptoms of all engine troubles are listed and methods indicated for treating each symptom. Possible causes of troubles and their cures are also listed under each symptom. The book, therefore, is a trouble finder and aid to those who wish to make minor repairs and adjustments.

Among the new matter added to this edition are the description and discussion of front-wheel drives and the description of the construction and repair of the Ford Model "A" automobile.

PROCESSES, methods and materials for "The Cleaning of Metal" with practical suggestions for their use are given in detail in a 76-page book written by Robert W. Mitchell and published by the Magnus Chemical Co., Garwood, N. J. In the Magnus method, cleaning is the result of a series of purely physical processes, although it is performed with material classed as chemical. Cleaning occurs in four steps: Wetting of the surface and penetration of the dirt by the cleaning solution; emulsification of the dirt and grease by the combined action of cleaner, agitation, and heat; stabilization of the emulsion or dirt suspension by soap or other film; dilution of the emulsion or suspension and its removal by rinsing.

GOULDS new electric sump-pump is described and illustrated in detail in a folder issued by Goulds Pumps, Inc., Seneca Falls, N. Y. A selection chart is also given showing capacities for various sizes and heads and the horsepower of motor required for driving.

POWER SYSTEM Master Plan is discussed in Publication No. 087 just issued by Power Systems Engineering Committee, Engineering National Section, National Electric Light Association, 420 Lexington Ave., New York. This committee has been at work for only two years. It was appointed to bring into one group those broad problems of system operation and development that reached into all aspects of the utility business. This committee has approached its work by trying to develop what it calls a master plan for utility operations whereby activities are coördinated and the system is expanded to conform to a planned analysis based on maximum returns from the use of men, money and equipment. This report on the Master Plan is an outline of this program and gives the philosophy of system planning. Reports are appended on Distribution Substations and High Load Density Distribution, both important elements of the Master Plan. Other reports will follow. Each of these reports should be studied in connection with the Master Plan Report and each other.

GIVING cast iron resistance to corrosion and heat effects by alloying with nickel, copper and chromium is the subject of an interesting paper read by J. S. Vanick and P. D. Merica before the American Society for Steel Treating. Copies are available on request to the International Nickel Co., New York, N. Y. The alloy is non-magnetic except by special treatment, has high electrical resistance, resists deterioration under heat as in stoker tuyeres three to six times as long as plain cast iron, and corrosion ten times as long. It can, however, be produced, cast and machined practically the same as gray iron.

TANNER GAS for overcoming the effect of moisture in compressed air lines and tools and Tanner Tanks for using this gas are explained and illustrated in bulletins issued by the Sullivan Machinery Co., 400 No. Michigan Ave., Chicago, Ill.

LINK-BELT Co., 200 South Belmont Ave., Indianapolis, Ind., is issuing a 32-page data book devoted to Promal Chains for power transmission and conveying services. It describes both plain links and attachments, gives dimensions, strengths, list prices and weights.

NEW FACILITIES for testing the Westinghouse OB detachable watthour meter have been developed. Distinctive features of the test jack embody the following: permanent test facilities for each meter are eliminated, actual test connections are made without tools, service is not disturbed in any way, and all live parts are adequately insulated. Bulletin L-20487 entitled, Test Jack for Type OB detachable watthour meters, describing this equipment, has been issued by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The company has also issued a new publication entitled Automatic Arc Welding Data Bulletin No. 14, featuring automatic arc welding. A number of automatic arc welding applications are described in this bulletin as well as actual cost comparison of hand and automatic welding.

DRIVES by roller chains are fully illustrated and described in Data Book No. 78 issued by the Diamond Chain & Mfg. Co., Indianapolis, Ind. The range covers from ¼ to 75 hp. and speed ratios up to 8.4 to 1 at speeds up to 1800 r.p.m. Illustrations of various applications are shown and full tables given for selection of chain and sprockets for any desired drive.

NEW TYPE E UNDERFEED STOKERS with center retort are described in a 28-page catalog issue by Combustion Engineering Corp., 200 Madison Ave., New York. This stoker is for burning either coking or non-coking bituminous coals and for various refuse fuels. It is applicable to boilers ranging from 150 up to 600 hp. Included in the catalog are line drawings showing suggested application to various types of boilers, a list of representative installations and test data.

CORRUGATED TRANSITE, a building material for roofing and siding, is described and its applications illustrated in a recent bulletin issued by Johns-Manville, 292 Madison Ave., New York City. It is designed to be fireproof, permanent, unaffected by ordinary industrial fumes and by the elements and to combine low cost with pleasing appearance. It is an asbestos-cement mixture formed under high pressure into flat or corrugated sheets.

FUSION WELDING, a new 18-page illustrated bulletin issued by The Babcock & Wilcox Co., 85 Liberty St., New York City, discusses a welding technique recently developed by the company as a result of extensive research work. Its application to the welding of pressure vessels was described in some detail in the Oct. 15 issue of Power Plant Engineering. The bulletin describes the process and shows how non-destructive tests were used, as well as other tests, to determine the quality of the welds.